FRECON i+1
High performance Inverter

User's Manual

High performance Inverter

0.4 to 300 kW.

APY ENGINEERING

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SAFETY INSTRUCTIONS

This instruction manual gives handling information and precautions for use of this inverter. Incorrect handling might cause an unexpected fault. Read this manual carefully before installing, connecting (wiring), operating, servicing, or inspecting the inverter. Familiarize yourself with all safety features before using this inverter. In this manual, safety messages are classified as follows:

WARNING	Improper operation may result in serious personal injury or death.
CAUTION	Improper operation may result in slight to medium personal injury or property damage.

Note that the CAUTION level may lead to a serious consequence according to conditions. Please follow the instructions of both levels because they are important to personal safety.

1.1 Instructions on Use

WARNING

- This inverter is designed to drive a 3-phase induction motor and is not suitable for a single phase motor or others, as fire may result.
- This inverter may not be used as a component of a life-support system or other medical device directly affecting the personal welfare of the user.
- Safety equipment must be installed or the failure of this device may result in personal injury, property damage, or if there is a risk of accident.

1.2 Instructions on Installation

WARNING

- Mount this inverter on an incombustible material such as metal. Installing the inverter directly on or near a combustible or flammable material could lead to a fire.

CAUTION

- Do not hold or carry this inverter by its cover, it may fall off.
- Do not drop the inverter, as injury may result.
- Ensure that the inverter and heat sink surfaces are kept free of foreign matter (lint, paper dust, small chips of wood or metal, and dust), as fire or accident may result.
- Do not install or operate a damaged inverter or an inverter with missing parts, as electric shock or injury may occur.

1.3 Instructions on Wiring

WARNING

- Connect the inverter to power via a line-protection molded-case circuit breaker or fuse, as fire may result. Always connect a ground wire, as electric shock or fire may result.
- A licensed specialist must perform all wiring work, as electric shock may result.
- Turn off the power before wiring, as electric shock may result.
- Always install the inverter before wiring, as electric shock or injury may occur.

CAUTION

- Confirm that the phases and rated voltage of this inverter match those of the AC power supply, as injury may result.
- Do not connect the AC power supply to the output terminals (U, V, W), as damage may result.
- Do not connect a resistor directly to the DC terminals (P, N), as fire may result.
- Do not fit capacitive equipment such as a power factor correction capacitor, noise filter or surge suppressor to the output of the inverter.
- The connection orientation of the output cables (U, V, W) to the motor will affect the direction of rotation of the motor.
- Ensure that the noise generated by the inverter, motor, or wiring does not adversely affect peripheral sensors and equipment, as accident may result.

1.4 Instructions on Operation

WARNING

- Be sure to install the front cover before turning on the power. Do not run the inverter with the front cover removed. Electric shock may occur.
- Do not operate switches with wet hands, as electric shock may result.
- The STOP key is valid only when the appropriate function setting has been made. Prepare an emergency stop switch separately.
- Make sure that the start signal is off before resetting the inverter alarm. A failure to do so may restart the motor suddenly.
- Do not touch inverter terminals when energized, even if the inverter has stopped. Electric shock may result.

CAUTION

- Do not start or stop the inverter using the main circuit power. Failure may result.
- Do not touch the heat sink or braking resistor because they become very hot. Burns may result.
- The inverter can be easily set for high-speed operation. Before changing its setting, examine the performance of the motor and machine. Injury may result
- The electronic over current protection does not guarantee protection of the motor from overheating.
- Before running an inverter which had been stored for a long period, always perform inspection and test operation.

1.5 Instructions on Maintenance, Inspection and Replacement

WARNING

- Wait a minimum of 5 minutes (30 HP or less) or 10 minutes (40 HP or more) after power has been turned off before starting inspection. Also confirm that the charge lamp is off and that DC voltage between terminals P and N does not exceed 25 V. Electrical shock may result.
- Only authorized personal should perform maintenance, inspection, and replacement operation. Remove all metal jewelry such as watches and rings. Use insulated tools only. Electric shock or injury may result.

CAUTION

- Do not carry out a megger (insulation resistance) test on the control circuit of the inverter.

1.6 Instructions on Disposal

CAUTION

- Treat as industrial waste when disposing of inverter.

1.7 Other Instructions

WARNNING

- Never modify the product. Electric shock or injury may result.

1.8 Conformity to Low Voltage Directive in Europe

CAUTION

- The contact capacity of alarm output for any fault (NO, NC, CMR) is 5 A at 30 VDC, 5 A ≤ 250 VAC
- The ground terminal should be connected to ground. Use a crimp terminal to connect a cable to the main circuit terminal or inverter ground terminal.
- Use a single cable to connect the inverter ground terminal. Do not use more inverter ground terminals.
- Where a residual-current protective device (RCD) is used for protection in case of direct or indirect contact, only a type B device is allowed on the supply side of this electrical equipment. Otherwise, another protective measure shall be applied such as separation of the electrical equipment from the environment by double or reinforced insulation or isolation of the electrical equipment and supply system by the transformer.
- Use a molded-case circuit breaker (MCCB) and magnetic contactor (MC) that conform to EN or IEC standards.
- Operate the inverter under over-voltage Category III conditions and maintain pollution Degree 2 or better as specified in IEC664. To maintain Pollution Degree 2 or better, install the inverter in a control panel structure (level NEMA 3 or higher) which is free from water, oil, carbon, dust etc.
- For the input-output wiring of the drive, use cable diameter and type as specified in Appendix C in EN60204.
- To ensure safety, install an optional AC reactor, DC reactor, or external braking resistor as follows:
  1) Install inside an IP4X cabinet or barrier if electrical parts are exposed.
  2) Install inside an IP2X cabinet or barrier if electrical parts are not exposed.
- In case of external cooling system, cover the inverter rear side in order not to touch the main capacitor and braking resistor.

1.9 General Instructions

- For clarity, some figures in this manual may show the inverter without covers for explanation purpose. Do not operate the device until all such covers have been replaced.

The time required for the capacitors to discharge after the removal of power from the equipment. Capacitor discharge time: Min. 5 minutes

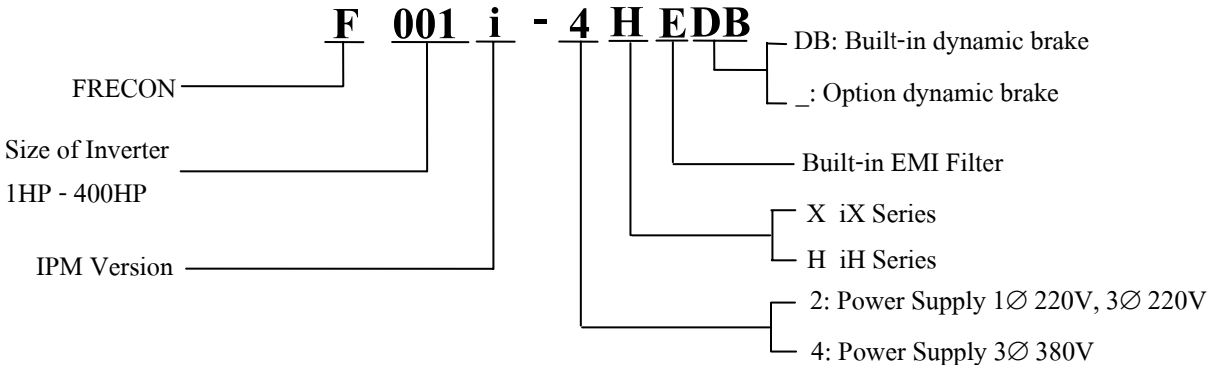
INTRODUCTION

Thank you for choosing this FRECON IH inverter. This inverter uses 32 bit CPU for multi-function in a variety of applications.

2.1 Inverter inspection

Please inspect the following points after unpacking your inverter. If you have any problems or questions regarding the inverter, please contact A.P.Y. Engineering Co., Ltd. or the distributor you purchased the unit from.

1) Check the nameplate on the inverter cover to ensure that the specifications correspond to those you ordered.
2) Inspect visually if during shipping the unit have got any damage or disconnection on the parts or bent on cover on main unit panels.



2.2 Product warranty

This product is guaranteed against defects in workmanship for 12 months from the purchasing date. However, the troubles caused by the following reasons are not covered by this warranty even in warranty period.

1) Problems caused by incorrect operation or by unauthorized repairs or modifications.
2) Problems resulting from using the inverter in the range outside the standard specification.
3) Damage to the inverter after purchase or during delivery.
4) Damage caused by earthquakes, fire, floods, lightning, abnormal voltage fluctuations or other natural disasters and secondary disasters.

5) Damage caused by water.

6) Damage caused by animal or insect.

7) The external case or parts are damaged.

8) Damage caused by intention, accident or carelessness

INSTALLATION AND WIRING

3.1 Operating Environment

Install this inverter in location that meets the conditions as follow.

Item	Specifications
Location	Indoors (a well-ventilated room)
Ambient Temperature	-10°C to +50°C (+14°F to +122°F)
Relative Humidity	5 to 95 % (No condensation)
Atmosphere	The inverter must not be exposed to dust, direct sunlight, corrosive gas, explosive gas, inflammable gas, oil mist, vapor, or water. There must be minimum salt content in the atmosphere. Do not store where condensation may occur as a result of sudden changes in temperature
Altitude	1000 m (3300 feet) or lower. After that derate by 3% for every extra 500 m up to 3000 m (88%)
Vibration	3 mm peak from 2 to 9 Hz, 9.8 m/s^2 from 9 to 20 Hz, 2m/s^2 from 20-55 Hz, 1 m/s^2 from 55 to 200 Hz.

Note: The storage environment: same as details of the operating environment.

3.2 Installation Method

- Install the inverter securely with screws or bolts in the vertical direction. Do not turn the inverter upside down or install in a horizontal position. Fig.3-1
- Since heat is generated during drive operation, the spaces shown in Fig.3-1 are required to ensure sufficient cooling. Do not install the inverter beneath a device sensitive to heat as heat radiates upward.
- The heat sink may reach a temperature of 90°C (194°F) during inverter operation. Ensure that the material surrounding the product can withstand this temperature.

- When installing this inverter in a control panel, consider ventilation to prevent the drive's ambient temperature from exceeding the specified value. Do not install the product in an area from which heat can not be sufficiently released.
- If two or more inverters must be installed in the same control panel, arrange the units horizontally to minimize the effect of heat. If two or more inverters must be installed vertically, place an insulated plate between the inverters to minimize the effect of heat.

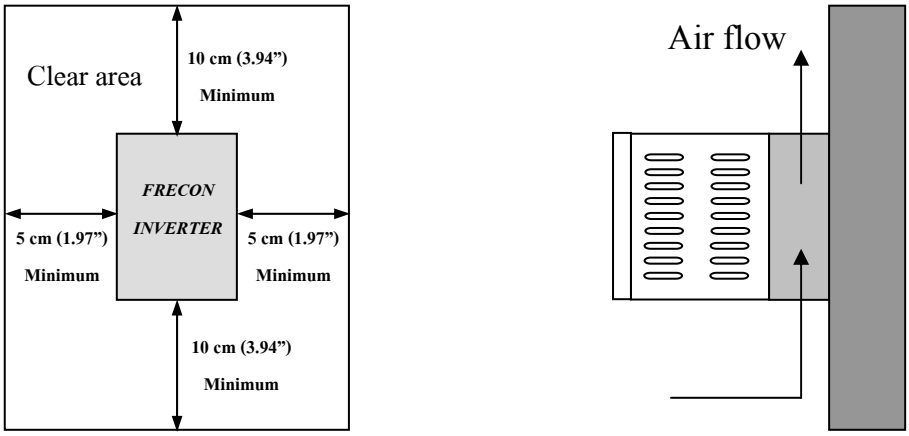


Fig.3-1

3.3 Wiring Method

3.3.1 Wiring of the main circuit

1) Crimping terminals with insulation sleeves are recommended for use with the power and motor cables.
2) Cut the protective bushes of the wiring cover when running the cables.
3) Check that the power supply voltage is within the maximum allowable voltage marked on the nameplate of the inverter. Connect the AC power input terminals (R/L1(L), S/L2, T/L3(N)) to the power supply via a mold-case circuit breaker for circuit protection.
4) Check that the voltage, current and power of motor are within the maximum allowable capacity marked on the nameplate of the inverter. Connect the inverter output terminals (U/T1, V/T2, W/T3) to a 3-phase motor in correct phase sequence.
5) Power supply must not be applied to the output terminals (U/T1, V/T2, W/T3) of the inverter. Otherwise the inverter will be damaged.
6) After wiring, wire off-cuts must not be left in the inverter. Wire off-cuts can cause a fault, failure or malfunction. Always keep the inverter clean. When drilling mounting holes in a control box etc., exercise care to prevent chips and other foreign matter from entering the inverter.

7) Use cables of the recommended size for wiring to make the voltage drop 2 % or less. If the wiring distance is long between the inverter and motor, a cable voltage drop will cause the motor torque to decrease especially at the output of low frequency.
8) Do not install a power factor correction capacitor or surge absorber in the output side of the inverter.
9) Do not connect a magnetic starter or magnetic contactor to the output side of the inverter. If the load is connected while the inverter is running, the inverter over current protective circuit operates because of inrush current.
10) The inverter should not be operated/stopped by opening/closing the magnetic contactor at the input side of the inverter. Frequent switching may cause the inverter to malfunction.
11) Connect only the recommended optional brake resistor between the terminals B1 and B2. These terminals must not be shorted.
12) When rewiring after operation, make sure that the power lamp has gone off, and when more than 10 minutes have elapsed after power-off, check with a tester that the voltage is zero. After that, start rewiring work.
13) AC or DC reactor should be connected under the following condition.
    - The capacity of the power supply transformer exceeds 500 kVA and exceeds the rated capacity of the drive tenfold. (See Fig.3-2)
    - Used to prevent the inverter over voltage trip from occurring when the power factor capacitor in the power line is switched on and off.
    - When the voltage imbalance exceeds 3 %

      Imbalance rate between phase [%] = (Max. voltage [V] – Min. voltage [V])/3 phase average voltage [V]

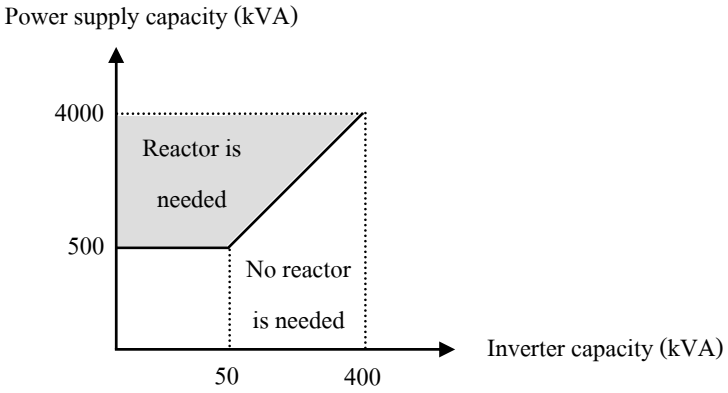


Fig.3-2

14) Do not run the power cables (input and output of the inverter) and signal cables of the inverter in parallel with each other and do not bundle them.

15) If the cable from the inverter to the motor is very long, a high-frequency current may be generated by stray capacitance between the cables and result in an over current trip of the inverter, an increase in leakage current, or a reduction in current indication precision.

3.3.2 Grounding instructions

1) Leakage currents flow in the inverter. To prevent an electric shock, the inverter and motor must be grounded (220V class …class 3 grounding, grounding resistance 100Ω maximum), (380V class … special class 3 grounding, grounding resistance 10Ω or less).
2) Use the dedicated ground terminal to ground the inverter. (Do not use the screw in the case, chassis, etc.)
3) Ground the motor on the inverter side using one wire of the 4-core cable.
4) When using several inverter units side by side, ground the units as shown in (a) or (b) of Fig.3-3. Do not loop the ground wires as shown in (c).

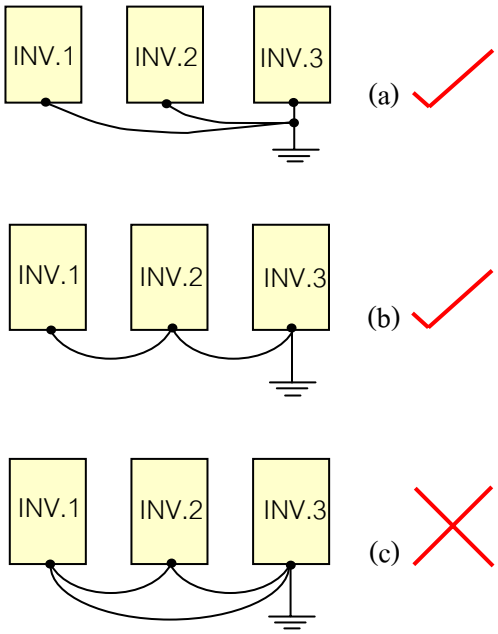
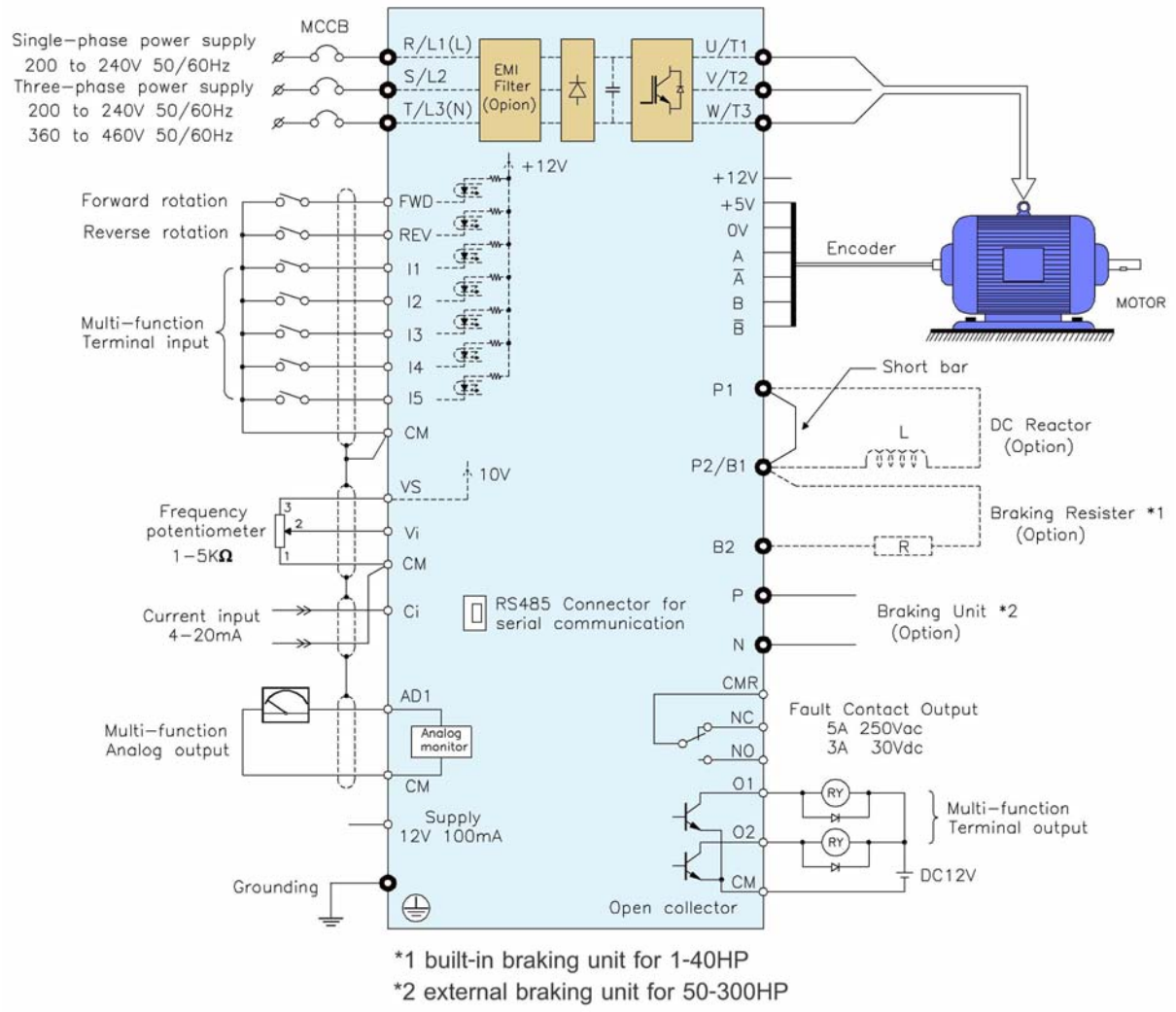


Fig. 3-3

3.3.3 Wiring of the control circuit

1) Separate control circuit wires from main circuit wires and other power cables to prevent erroneous operation caused by noise interference.
2) Use twisted shield or twisted-pair shielded wire for the control circuit line and connect the shielded sheath to the ground.
3) A wiring distance should be less than 20 m.

3.3.4 Wiring diagram



*1 built-in braking unit for 1-40HP
*2 external braking unit for 50-300HP

Terminals

Vs	Vi	Ci	CM	AD1	O1	O2	FWD	REV	CM	I1	I2	I3	I4	I5	CM	+12

NO	CMR	NC

Terminal	Description
R/L1 (L) S/L2 T/L3 (N)	Connect to the commercial power supply
U/T1 V/T2 W/T3	Connect to a 3-phase induction motor
P1	Connect to DC reactor (P1)
P2/B1	Connect to DC reactor (P2) or braking resistor (B1)
B2	Connect to braking resistor (B2)
P	Connect to external braking unit (DC Bus +)
N	Connect to external braking unit (DC Bus -)
⏚	Connect the inverter chassis(case) to earth

Terminal	Description
VS	DC power supply 10V 15mA.
Vi, Ci	Multi-function analog input terminals
I1, I2, …, I5	Multi-function digital input terminals
O1,O2	Multi-function digital output terminals
AD1	Multi-function analog output terminal
FWD	Turn on to start forward rotation
REV	Turn on to start reverse rotation
+12	DC power supply 12V 100mA.
CM	Analog and Digital signals ground
NO	Fault contact normally open
NC	Fault contact normally close
CMR	Fault contact common

HOW TO USE KEYPAD

STATUS LED

Show mode of the inverter

DISPLAY

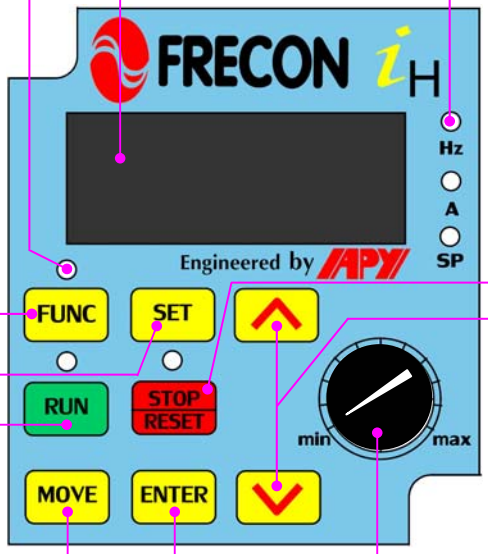
Show command value (frequency, torque, SP) or data in program mode

UNIT LED

Show unit of display value

FUNC KEY

Press to select program mode and toggle to operation mode



STOP KEY

Press to stop the inverter or reset fault

SET KEY

OPR mode: press to remember command value

PRG mode: press to save data in a function

UP/DOWN KEY

OPR mode: press to increase or decrease command value

PRG mode: press to increase or decrease data in a function

RUN KEY

OPR mode: press to run the inverter

VOLUME

OPR mode: adjust command value to increase or decrease

MOVE KEY

OPR mode: press to select digit of command value to changing

PRG mode: press to select digit of data to changing

ENTER KEY

OPR mode: press to display motor current or PID feedback

PRG mode: press to display data in a function

INVERTER OPERATION

5.1 Pre-operation inspection

Check the following items before supplying power to the inverter.

1) Check that the connections are correct. In particular, check that inverter terminals U, V and W are not connected to the power supply, and also check that the ground terminal is securely grounded.
2) Check for short circuits and ground faults between the terminals and sections under power.
3) Check for loose terminals, connectors, or screws.
4) Check that the motor is disconnected from the mechanical equipment.
5) Turn all switches off before turning on the power to make sure that the inverter does not start up or operate incorrectly when the power is turned on.
6) Check the following after power-on:
   6.1) No fault message is displayed on the keypad panel.
   6.2) The fan inside the inverter is rotating.

5.2 Power On

When the power is turn on, keypad shows “APY” and after that it shows the factory setting frequency (50.00 Hz). The inverter is in the stop mode. Note that the LED over the stop key is lit.

5.3 Program mode

1) Press *FUNC* key for entering the program mode. The display shows the function number “A-00”. If the display shows “PASS”, the program mode of inverter is locked. User can enter the program mode by press *MOVE* key, *RUN* key and *SET* key respectively.
2) Press *UP* or *DOWN* key to increase or decrease the basic function number. If user wants to enter the other program mode, press *MOVE* key one time. The character “A” is blink and then press *UP* or *DOWN* key to change it. (Fig. 5.1)
3) Press *ENTER* key to show the parameter in each function.
4) Press *UP* or *DOWN* key to change the parameter in the desire function.
5) Press *SET* key to save the parameter in memory. If user wants to change the parameter in the other function, please follow in 2)-5) again.
6) Press *FUNC* key to exit the program mode.

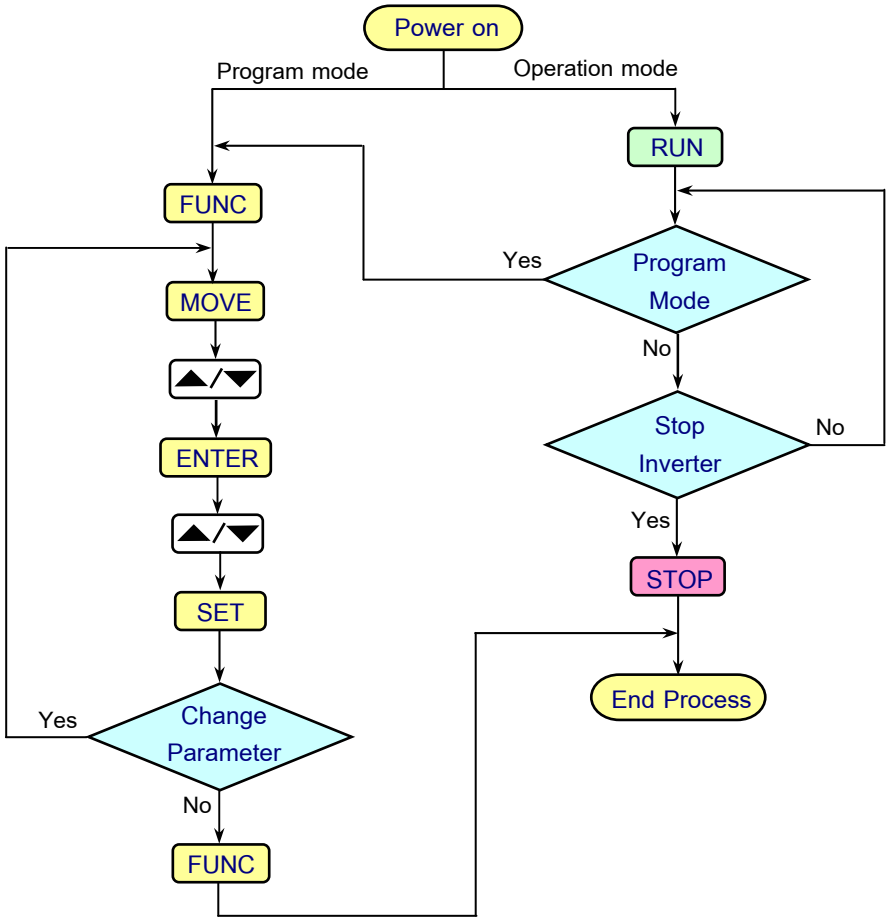


Fig. 5-1

5.4 Keypad operation

1) In stop mode, change the frequency to the desire value by pressing *UP* or *DOWN* key.
2) Press *RUN* key to start the inverter. The motor speed will be increased to the set frequency. The acceleration time corresponds to the parameter in A-10. The direction of rotation depends on the FWD/ REV terminals.
3) Press *ENTER* key to display the motor current and press *ENTER* key again to return the frequency display.
4) Press *STOP* key to stop the inverter. The motor speed will be decreased until stop. The deceleration time corresponds to the parameter in A-11.

5.5 External operation mode (Operation using external input signals)

1) Select external operation mode in A-03. (see in function details)
2) Close the terminal FWD-CM or REV-CM. (depend on the desire direction of rotation)
3) Select the external speed command in A-04. (see in function details)

FUNCTION TABLE

Code	Basic Functions	Data	Default	Control Mode	Control Method
A-00	Monitor display selection	1. Frequency (Hz) 2. Revolution speed (rpm) 3. Machine speed	1	SPD	ALL
A-01	Machine speed coefficient	0.01~200.00 multiply to frequency value	1.00		
A-02	Pole pair	1~8 (motor poles/2)	2	ALL	ALL
A-03	Operation method	1. Start/Stop by keypad 2. Start/Stop by external pattern1 3. Start/Stop by external pattern2 4. 3-wire operation 5. RS485 operation (MODBUS-RTU) 6. Line/Inverter changeover operation	1	ALL	ALL
A-04	Inverter command selection	1. Keypad command 2. External command from terminal Vi 3. External command from terminal Ci 4. External command from terminal Vi+Ci 5. External command from terminal Vi-Ci 6. UP/DOWN command 7. RS485 command (MODBUS-RTU) 8. Volume keypad command 9. Keypad command (Start at zero frequency)	1	ALL	ALL
A-05	V/F pattern	1. Linear pattern 2. Square-law pattern	1	SPD,PID	V/F
A-06	Base voltage	80~240V. (220V. Series) 200~460V. (380V. Series)	220 380	SPD,PID	V/F
A-07	Base frequency	30.00~600.00 Hz	50.00	ALL	ALL
A-08	Minimum frequency	0.00~Maximum frequency (Hz)	0.00	SPD,PID	ALL
A-09	Maximum frequency	Minimum frequency~600.00 Hz	120.00		
A-10	1st acceleration time	0.0~6000.0 sec	5.0	ALL	ALL
A-11	1st deceleration time	0.0~6000.0 sec	5.0		
A-12	Torque boost	0.0~20.0% of base voltage	3.0	SPD,PID	V/F
A-13	Maximum frequency for torque boost	0.0~100.0% of base frequency	10.0		
A-14	Slip compensation	0~200% of rated motor slip	0	SPD,PID	V/F
A-15	Slip compensation during regenerative	0. Inactive 1. Active	0		

Code	Basic Functions	Data	Default	Control Mode	Control Method
A-16	Starting method	1. Start frequency 2. Start frequency after DC braking 3. Flying start (Search speed)	1	SPD,PID	ALL
A-17	Start frequency	0.50~50.00 Hz (V/F & SSL) 0.00~50.00 Hz (VEC)	0.50	SPD,PID	ALL
A-18	Hold time at start frequency	0.0~60.0 sec	0.0		
A-19	DC brake start duty	1~100% of rated motor current	30	SPD,PID	V/F,SSL
A-20	DC brake start time	0.0~60.0 sec	0.0	SPD,PID	ALL
A-21	Braking method	1. Deceleration & stop 2. Deceleration & stop + DC braking 3. Free run stop (Coasting to stop)	1	SPD,PID	ALL
A-22	Stop frequency	0.50~50.00 Hz (V/F & SSL) 0.00~50.00 Hz (VEC)	0.50	SPD,PID	ALL
A-23	DC brake stop duty	1~100% of rated motor current	30	SPD,PID	V/F,SSL
A-24	DC brake stop time	0.0~60.0 sec	0.0	SPD,PID	ALL
A-25	Switching frequency	1~15 kHz	3	ALL	ALL
A-26	Factory setting	0. Inactive 1. Active 2. Program locked	0	ALL	ALL

Code	Multi-step Functions	Data	Default	Control Mode	Control Method
B-00	2nd acceleration time	0.0~6000.0 sec	5.0	ALL	ALL
B-01	2nd deceleration time				
B-02	3rd acceleration time				
B-03	3rd deceleration time				
B-04	4th acceleration time				
B-05	4th deceleration time				
B-06	5th acceleration time				
B-07	5th deceleration time				
B-08	6th acceleration time				
B-09	6th deceleration time				
B-10	7th acceleration time				
B-11	7th deceleration time				
B-12	8th acceleration time				
B-13	8th deceleration time				
B-14	Jog acceleration time				
B-15	Jog deceleration time				

Code	Multi-step Functions	Data	Default	Control Mode	Control Method
B-16	Soft acceleration time	0.0~6000.0 sec	10.0	ALL	ALL
B-17	Soft deceleration time				
B-18	S-curve accel start time	0.0~6000.0 sec	0.0		
B-19	S-curve accel end time				
B-20	S-curve decel start time				
B-21	S-curve decel end time				
B-22	1st speed limit	0.00~600.00 Hz	10.00	TRQ	VEC,SSL
B-23	2nd speed reference/ 2nd speed limit		20.00	SPD,TRQ	ALL
B-24	3rd speed reference / 3rd speed limit		30.00		
B-25	4th speed reference / 4th speed limit		40.00		
B-26	5th speed reference / 5th speed limit		50.00		
B-27	6th speed reference / 6th speed limit		60.00		
B-28	7th speed reference / 7th speed limit		70.00		
B-29	8th speed reference / 8th speed limit		80.00		
B-30	Jog speed reference/ Jog speed limit		5.00		
B-31	1st Jump frequency bottom	0.00~1st Jump frequency top (Hz)	0.00	SPD,PID	ALL
B-32	1st Jump frequency top	1st Jump frequency bottom~600.00 Hz			
B-33	2nd Jump frequency bottom	0.00~2nd Jump frequency top (Hz)			
B-34	2nd Jump frequency top	2nd Jump frequency bottom~600.00 Hz			
B-35	3rd Jump frequency bottom	0.00~3rd Jump frequency top (Hz)			
B-36	3rd Jump frequency top	3rd Jump frequency bottom~600.00 Hz			
B-37	2nd torque reference	0.0~200.0%	20.0	TRQ	VEC,SSL
B-38	3rd torque reference		30.0		
B-39	4th torque reference		40.0		
B-40	5th torque reference		50.0		
B-41	6th torque reference		60.0		
B-42	7th torque reference		70.0		
B-43	8th torque reference		80.0		
B-44	Jog torque reference		10.0		
B-45	PID reference accel / decel time	0.0~60.0 sec	0.0	PID	ALL
B-46	2nd PID reference	0.0~100.0%	20.0	PID	ALL
B-47	3rd PID reference		30.0		
B-48	4th PID reference		40.0		
B-49	5th PID reference		50.0		
B-50	6th PID reference		60.0		
B-51	7th PID reference		70.0		
B-52	8th PID reference		80.0		
B-53	Jog PID reference		10.0		

Code	Terminal Functions	Data	Default	Control Mode	Control Method
C-00	Digital input terminal1 (I1)	1. Multi-step frequency1 (X1)	1	ALL	ALL
C-01	Digital input terminal2 (I2)	2. Multi-step frequency2 (X2)	2		
C-02	Digital input terminal3 (I3)	3. Multi-step frequency3 (X3)	3		
C-03	Digital input terminal4 (I4)	4. Jog frequency (JOG)	4		
C-04	Digital input terminal5 (I5)	5. External reset (RST)	5		
		6. Reset hold (RH)			
		7. Up command (UP)			
		8. Down command (DOWN)			
		9. ACC / DEC selection (SOFT)			
		10. Free run (FR)			
		11. External fault (THR)			
		12. Line / Inverter changeover selection (CS)			
C-05	Digital output terminal1 (O1)	1. Start / Stop signal (SST1)	1	ALL	ALL
C-06	Digital output terminal2 (O2)	2. Start / Stop signal with DC brake (SST2)	3		
		3. Frequency agree signal (FAR)			
		4. Frequency level detection signal (FDT)			
		5. Overload warning signal (OLW)			
		6. Inverter magnetic contactor signal (MCI)			
		7. Line magnetic contactor signal (MCL)			
C-07	SST2 in DC brake start	0~100%	50	SPD,PID	ALL
C-08	SST2 in DC brake stop				
C-09	FAR hysteresis	0.00~10.00 Hz	0.00	SPD	ALL
C-10	FDT level	0.00~600.00 Hz	50.00		
C-11	FDT hysteresis	0.00~30.00 Hz	0.00		
C-12	Analog input terminal Vi	1. 0-10 V.	1	ALL	ALL
		2. -10 to 10 V. (Option card)			
		3. 4-20 mA. (Modify board)			
C-13	Bias setting for Terminal Vi	0.0~Gain setting of Terminal Vi (at 0V. or 4 mA.)	0.0		
C-14	Direction of bias Terminal Vi	1. Positive	1		
		2. Negative			
C-15	Gain setting of Terminal Vi	Bias setting of Terminal Vi ~600.00 Hz (at 10V. or 20mA.)	100.0		

Can't change during operation

Can change during operation

Control mode

1. *SPD = Speed mode (E-00 = 1, 2)*
2. *PID = PID build-in mode (E-00 = 3, 4)*
3. *TRQ = Torque mode (E-00 = 5, 6)*
4. *ALL = SPD, PID and TRQ*

Control method

1. *V/F = V/F control (E-01 = 1)*
2. *VEC = Vector control (E-01 = 2)*
3. *SSL = Sensorless control (E-01 = 3)*
4. *ALL = V/F, VEC and SSL*

Code	Terminal Functions	Data	Default	Control Mode	Control Method
C-16	Analog input Terminal Ci	1. 0-10 V. (Modify board) 2. -10 to 10 V. (Option card) 3. 4-20 mA.	3	ALL	ALL
C-17	Bias setting for Terminal Ci	0.0~Gain setting of Terminal Ci (at 0V. or 4mA.)	0.0		
C-18	Direction of bias Terminal Ci	1. Positive 2. Negative	1		
C-19	Gain setting of Terminal Ci	Bias setting of Terminal Ci ~600.00 Hz (at 10V. or 20mA.)	100.0		
C-20	Analog input filter	0.00~3.00 sec	0.10		
C-21	Analog output terminal AD1	1. 0-10V 2. 4-20mA (Modify board)	1	ALL	ALL
C-22	Analog output signal AD1	1. Show inverter set point 2. Show inverter set point run 3. Show motor current 4. Show motor voltage 5. Show motor speed 6. Show motor torque 7. Show motor power 8. Show DC bus voltage 9. Show PID feedback	2		
C-23	Adjust analog output signal	0~200% of duty	100		
C-24	Station address	0 (Master mode), 1~247 (Slave mode)	1	ALL	ALL
C-25	Communication speed	1. 2400 bits/sec 2. 4800 bits/sec 3. 9600 bits/sec 4. 19200 bits/sec	3		
C-26	Data format	1. 8-N-1 (No parity & 1 stop bit) 2. 8-N-2 (No parity & 2 stop bit) 3. 8-E-1 (Even parity & 1 stop bit) 4. 8-O-1 (Odd parity & 1 stop bit)	1		
C-27	Reply interval	0.00~1.00 sec.	0.01		
C-28	Communication loss time out	0.0~60.0 sec.	0.0		
C-29	Time out action	0. Continuous operation 1. Decel to stop (up to A-21) 2. Fault and Coasting to stop	0		
C-30 C-31	Digital ratio multiplier Digital ratio divisor	1~9999	100		

Code	Protective Functions	Data	Default	Control Mode	Control Method
D-00	Electronic thermal overload	0. Inactive 1. Flat rate 2. Derate	1	ALL	ALL
D-01	Electronic thermal overload level	20~105% of rated inverter current	80		
D-02	Stall prevention	0. Inactive 1. Stall prevention current 2. Stall prevention voltage 3. Stall prevention current + voltage	3	SPD,PID	ALL
D-03	Stall prevention current level	50~200% of rated inverter current	150	SPD,PID	V/F
D-04	Stall prevention voltage level	80~100% of maximum voltage	90	SPD,PID	ALL
D-05	Auto restart method	0. Inactive 1. Start frequency 2. Start frequency after DC braking 3. Flying start (Search speed)	0	SPD,PID	ALL
D-06	Restart time	0.0~60.0 sec	0		
D-07	History fault	[1] [2] [3] [4] [1] = The last history fault [2] = The third history fault [3] = The second history fault [4] = The first history fault	0000	ALL	ALL
D-08	Line MC interlock time	0.00~60.00 sec.	0.10	SPD	V/F
D-09	Inverter MC interlock time	0.00~60.00 sec.	3.00		
D-10	Advanced phase output voltage	0~360 degree	0		
D-11	Motor wiring protection	0. Not check motor wiring 1. Check motor wiring	0	ALL	ALL

Code	Technique Functions	Data	Default	Control Mode	Control Method
E-00	Control mode	1. Speed mode 2. Speed mode + Energy save* 3. PID + Speed mode 4. PID + Speed mode + Energy save* 5. Torque mode 4 quadrant 6. Torque mode 3 quadrant	1	ALL	ALL
E-01	Control method	1. V/F (Open loop) 2. Vector (With speed sensor) 3. Senserless (Without speed sensor)	1	ALL	ALL
E-02 E-03	Speed loop proportional gain (Kp) Speed loop integral time (Ti)	1~9999	500	ALL	VEC,SSL

Code	Technique Functions	Data	Default	Control Mode	Control Method
E-04	Torque limiter	0~200% of rated motor torque	100	ALL	VEC,SSL
E-05	PID controller feedback	1. Feedback from terminal Vi 2. Feedback from terminal Ci 3. Feedback from terminal Vi + Ci	2	PID	ALL
E-06	PID proportional band (PB)	0.1~1000.0%	100.0		
E-07	PID integral time (Ti)	0.0~600.0 sec.	1.0		
E-08	PID differential time (Td)	0.00~60.00 sec.	0.00		
E-09	PID action selection	1. Direct action 2. Reverse action	2		
E-10	Pulses of encoder	1~9999 pulses/rev	1024	ALL	VEC
E-11	Rated motor speed	1~9999 rpm	1420	ALL	ALL
E-12	Magnetizing current	1~100% of rated inverter current	size		
E-13	Rated motor current	1~200% of rate inverter current	size		
E-14	Autotune parameters	0. Inactive 1. Rotate tuning 2. Standstill tuning	0	ALL	VEC,SSL
E-15	Size of inverter	P01~P400 (380V. Series) 0.5HP~75HP (220V. Series)	size	ALL	ALL
E-16	Size of motor	P01~P400 (380V. Series) 0.5HP~75HP (220V. Series)	size		
E-17	Voltage gain	80~240V. (220V. Series) 200~460V. (380V. Series)	factory	ALL	ALL
E-18	Current gain	1~9999	size		
E-19	Deadtime compensation	0~100% of 6.25 usec	size		
E-20	DC bus voltage compensation	1. Used DC bus voltage 2. Fixed DC bus voltage at 310V. or 540V.	1	SPD,PID	V/F
E-21 E-22	CCL proportional gain (Kp) CCL integral time (Ti)	1~9999	500	ALL	VEC,SSL
E-23 E-24	Adaptive gain (Kp) Adaptive integral time (Ti)	1~9999	500	ALL	SSL
E-25 E-26 E-27 E28	Stator resistance (Rs) Rotor resistance (Rr) Leakage inductance (σLs) Stator inductance (Ls)	1~9999	size	ALL	VEC,SSL
E-29	Torque filter / Current filter	1~256	128	ALL	ALL
E-30	Inverter version	-	-	-	-

BASIC FUNCTIONS

A-00 Monitor Display Selection

- This function is used for setting the displayed value on keypad which is used as the command value in the speed-control mode (SPD).

Data	Description
1	The frequency is displayed and can be set from 0.00 ~ 600.00 Hz (LED lit at Hz position).
2	The motor speed (LED lit at M/S position) is displayed. The displayed value depends on the data in function A-02 as following equation: *Speed = 60 * frequency / pole pair (A-02)* ....(1)
3	The machine speed (LED lit at M/S position) is displayed. The displayed value depends on the data in function A-01 as following equation: *Machine speed = coefficient(A-01) * frequency* ....(2)

Remark:

- In the torque-control mode (TRQ). The keypad displays the torque command value in percentage that up to the size of motor.
- In the PID-controller mode. The keypad displays the command value of the PID controller in percentage that up to the rated value of the sensor.

A-01 Machine Speed Coefficient

- The coefficient in this function is used as the multiplier in the equation (2). The value can be set from 0.01~200.0

Example If we want to display the machine speed as 5.0 m/s when the motor is running at 50 Hz, we must use the coefficient value equals 0.1

A-02 Pole Pair

- This function is used for setting the pole pair of motor which equal to the number of motor's pole divided by 2 The value can be set from 1~8.

Example The 4-poles motor has 2 pole pairs.

A-03 Operation Method

- This function is used for setting the start and stop method of the inverter in every control mode.

Data	Description
1	Control the operation via the RUN/STOP button on the keypad and set the spin direction via the CM-FWD or CM-REV connection as shown in figure 1.
2	External Command (Format 1): Control the operation and the spin direction via the CM-FWD or CM-REV connection by using switch or relay contact as shown in figure 2.
3	External Command (Format 2): Control the operation via the CM-FWD connection and set the spin direction via the CM-REV connection as shown in figure 3.
4	3-wire operation control: Control the operation via the CM-RH connection and set the spin direction via the FWD or REV connection as shown in figure 4 and 5.
5	Control the operation via the RS485 MODBUS RTU communication.
6	External Command for Line change-over mode: Use the 3-wire operation control scheme in addition with the using of the CS connection as the Line-Inverter transfer selector and the MCI, MCL connection as the Magnetic contactor controller (optional card). The wiring diagram is shown in figure 26 and the operation is also shown in figure 27.

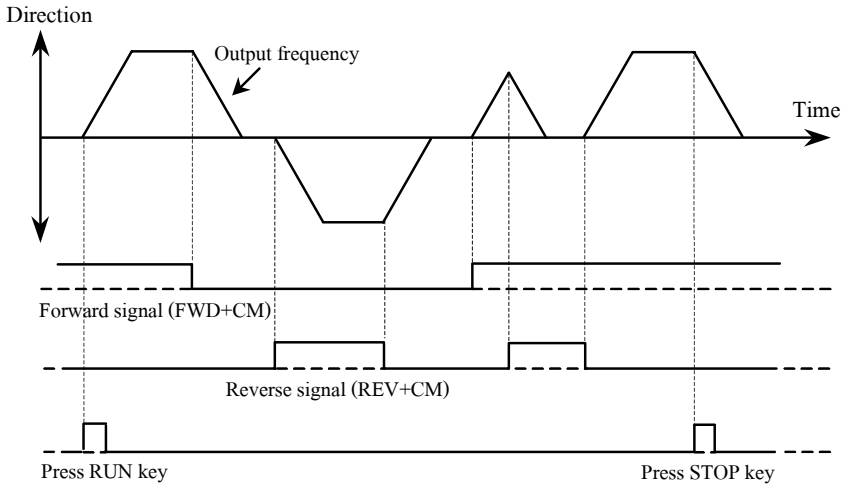


Figure 1 The sequence of operation control by keypad

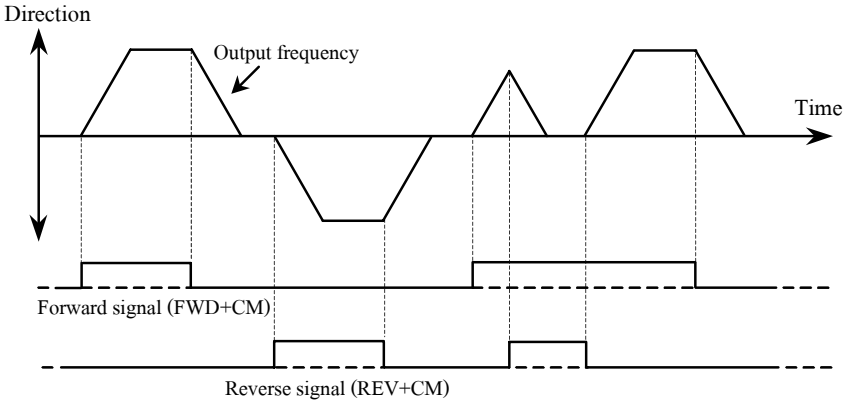


Figure 2 The sequence of the external operation control in format 1

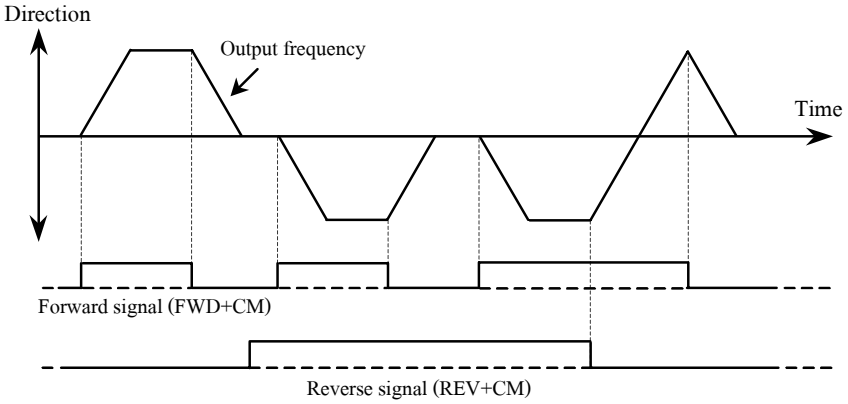


Figure 3 The sequence of the external operation control in format 2

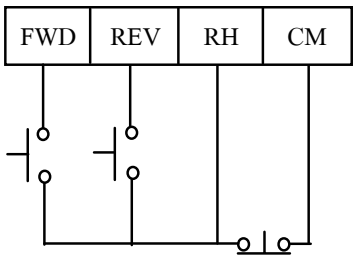


Figure 4 Connection for the 3-wire operation control

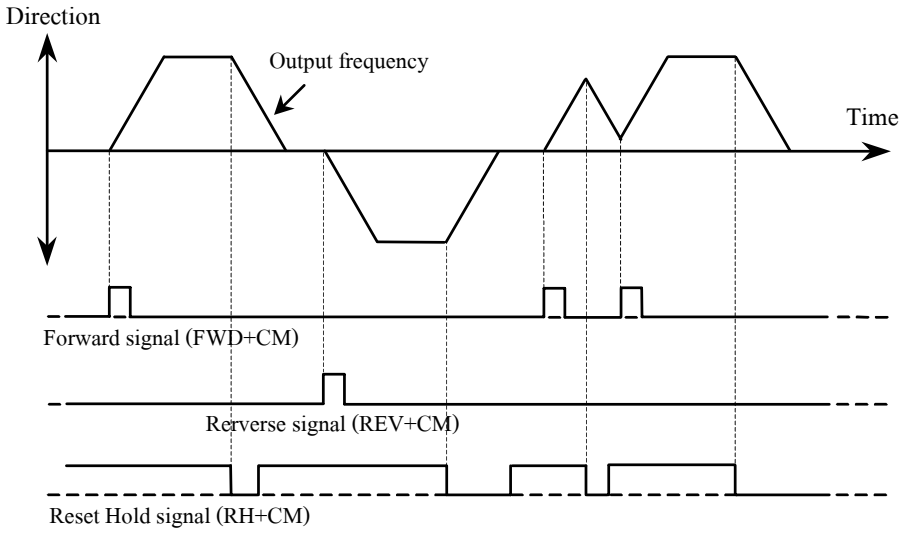


Figure 5 The sequence of the 3-wire operation control

A-04 Inverter Command Selection

- This function is used for inverter command selection (Digital, Analog or UP/DOWN control).
- The command value will be used as the speed command (1st speed reference), the torque command (1st torque reference) or the PID controller command (1st PID reference) depending on the control mode (function E-00).

Data	Description
1	Digital Command: Adjust the set point via ∧/∨ button on the keypad with the 0.01 Hz resolution.
2	Analog Voltage Command: Adjust the set point by the 1~5kΩ potentiometer or the 0~10V external input voltage connected to the Vi terminal. More details can be set in function C-12 to C-15.
3	Analog Current Command: Adjust the set point by the 4~20mA current source/sensor connected to the Ci terminal. More details can be set in function C-16 to C-19.
4	The set point is the summation of the analog voltage at the Vi terminal and the analog current at the Ci terminal.
5	The set point is the difference between the analog voltage at the Vi terminal and the analog current at the Ci terminal.
6	External Command: Increase or decrease the set point via the CM-UP and CM-DOWN connection respectively. Figure 6 shows the example when using with the format 1 external operation control.
7	Adjust the set point via the RS485 MODBUS RTU communication
8	Adjust the set point via the volume knob on the keypad.
9	Start running from zero set point and can adjust the set point via ∧/∨ button on the keypad with the 0.01 Hz resolution.

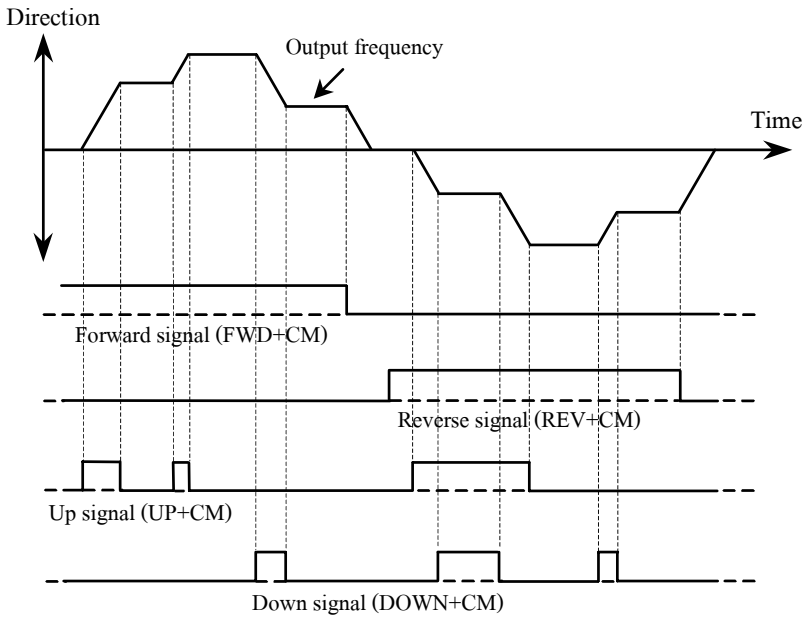


Figure 6 The sequence of operation when receiving the set point command from UP/DOWN

A-05 V/F Pattern

- This function is used for the voltage/frequency pattern selection when using the V/F control mode.

Data	Description
1	Linear pattern: The pattern relation between the voltage and frequency is linear. Using for constant load torque, such as Conveyor etc. (see Figure 7)
2	Square pattern: The pattern relation between the voltage and frequency is square function. Normally using with the Fan or Pump load. (see Figure 7)

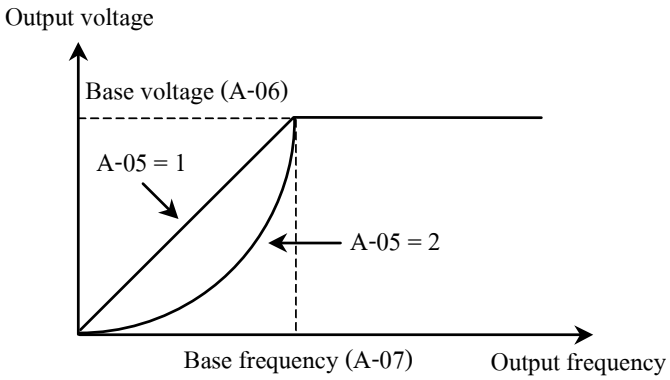


Figure 7 The pattern of output voltage and frequency

A-06 Base Voltage

- This function is specified by the rated voltage of motor for using in the V/F control mode (see Figure 7). The value can be set from 80V to 240V for 220V inverter model and 200V to 460V for 380V inverter model.

Remark:

- The maximum output voltage of inverter cannot be over the input voltage of inverter.

A-07 Base Frequency

- This function is specified by the rated frequency of motor. The value in this function is used for partitioning between the constant torque and the constant power (field weakening) range as seen in figure7. The value can be set from 30.0Hz to 600.00Hz.

A-08 Minimum Frequency

- This function is used as the minimum limit of the output frequency to protect the motor from operating at improper frequency (see Figure 8). The value can be set from 0.00Hz to the maximum frequency (A-09).

A-09 Maximum Frequency

- This function is used as the maximum limit of the output frequency to protect the motor from operating at improper frequency (see Figure 8). The value can be set from the minimum frequency (A-08) to 600.00Hz.

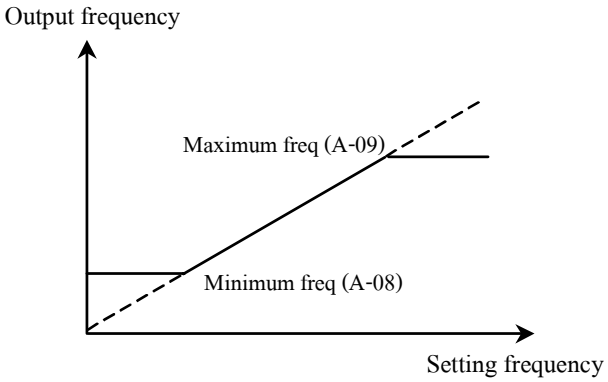


Figure 8 Maximum and minimum limit of the output frequency

A-10 1st Acceleration Time

A-11 1st Deceleration Time

- These functions are used for setting the linear acceleration and deceleration time of motor for the first speed command (1st speed reference). The values can be set from 0.0 to 6000.0 second.
- The time values in the function A-10 and A-11 are used as the linear middle-time for the S-curve operation together with the start and end time in the function B-18~ B-21 based on 50 Hz, which mean that if we set A-10 and A-11 to be 5 and B-18~B-21 to be 0, the motor will accelerate from 0.00 Hz to 50.00 Hz in 5 second and also decelerate from 50.00 Hz to 0.00 Hz in 5 second.

Example If we want the linear acceleration and deceleration time of motor between 0.00Hz~100.0Hz to be 5 second, we must set the function A-10 and A-11 to be 2.5 and B-18~B-21 to be 0 (see Figure9).

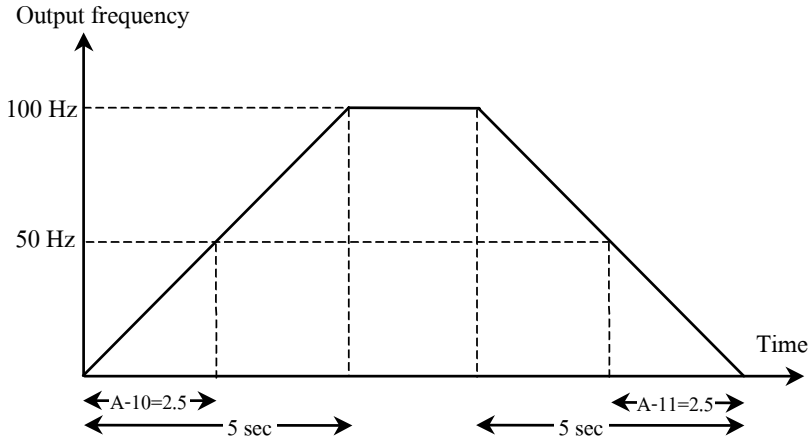


Figure9 Setting acceleration and deceleration speed time is linear

Remark:

- In the torque-control mode (TRQ), this function is used for setting the linear acceleration and deceleration time of the torque value for the fist torque command (1st torque reference).
- In the PID controller mode, this function is used for setting the linear acceleration and deceleration time of the frequency value for the of PID controller command (1st PID reference).

A-12 Torque Boost

- This function is used for setting the starting output voltage for increasing the torque of motor at the low frequency operation in the V/F control mode (see Figure 10, 11). The value can be set from 0.0 to 20.0% of base voltage (A-06).

A-13 Maximum Frequency for Torque Boost

- This function is the maximum frequency for increasing the output voltage in the V/F control mode (see Figure 10, 11). The value can be set from 0.0 to 100.0% of base frequency (A-07).

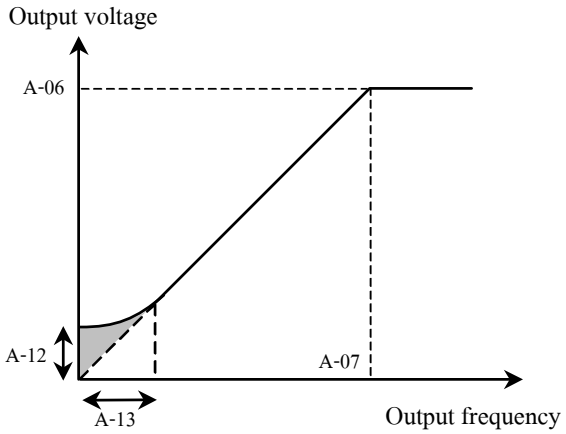


Figure 10 Example of the torque boosting in V/F control (linear pattern)

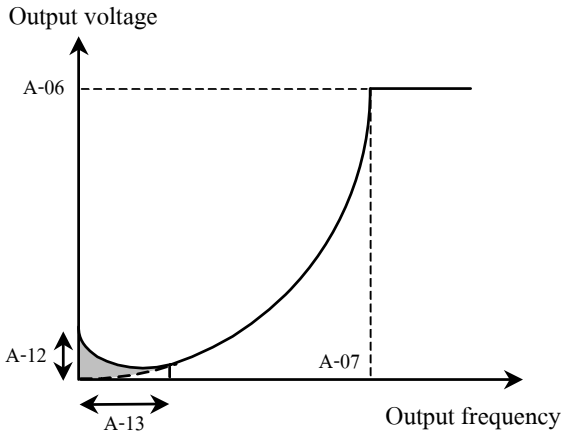


Figure 11 Example of the torque boosting in V/F control (square pattern)

A-14 Slip Compensation

- This function is used to compensate the decreasing speed that caused from load in the V/F control mode. The value can be set from 0~200% of the rated slip. The compensation result can be shown as in figure 12.
- For the correct slip compensation, user must set the correct data in following functions:
  - Rated speed of motor in function E-11
  - No load current in function E-12
  - Rated current of motor in function E-13

A–15 Slip Compensation during Regenerative

Data	Description
0	No slip compensation in the regenerative region.
1	Do slip compensation in the motor and regenerative region.

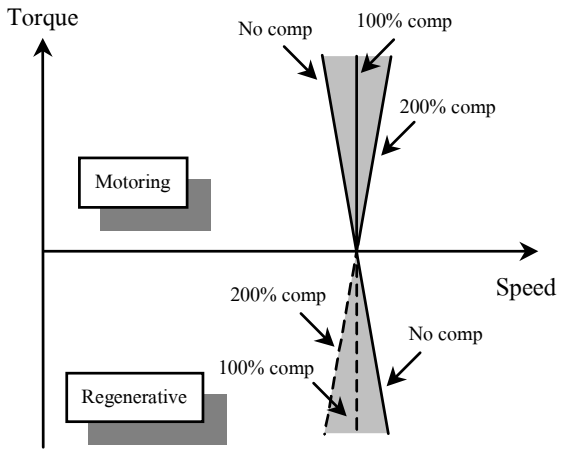


Figure 12 Slip compensation in the motoring and regenerative region

A-16 Starting Method

- This function is used for the motor starting method selection before the speed is accelerated to the set point.

Data	Description
1	Start from the starting frequency. (More details in function A-17 and A-18)
2	Start from the starting frequency after the DC braking. This setting can decrease the starting current because the motor is slow down or stop already. (More details in function A-19 and A-20)
3	Start by the search speed technique. This method is good for starting the motor that is still spinning because the inverter will try to apply the matched frequency that making low slip leading to the low starting current as seen in figure 13.

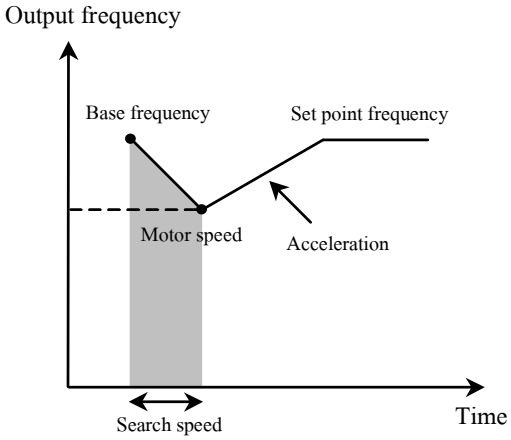


Figure 13 The speed searching in V/F and sensorless control mode

Remark:

- In the V/F and sensorless (SSL) control mode, the search-speed technique should be applied only when the speed of motor below the base frequency (A-06).

A-17 Start Frequency

- This function is used for setting the starting frequency of motor as seen in figure 14. The value can be set from 0.00~50.00 Hz in the Vector control mode (VEC) or 0.50~50.00 Hz in the V/F and sensorless (SSL) control mode.

Remark:

- The inverter can be started only when the set point frequency is more than or equal to the start frequency.

A-18 Hold Time at Start Frequency

- This function is used for setting the start frequency holding time as seen in figure 14. The value can be set from 0.0~60.0 second.

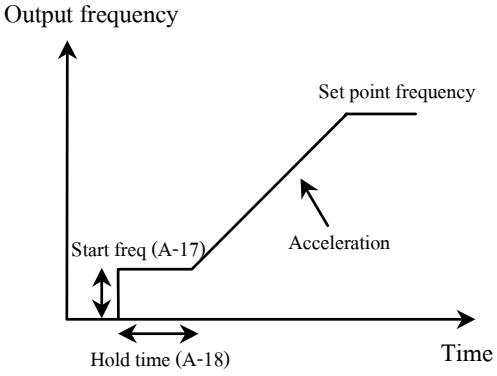


Figure 14 The start frequency and its holding time

A-19 DC Brake Start Duty

- This function is used for setting the power (duty) of DC braking before start running the motor as seen in figure 15. The value can be set from 1~100% of the rated current of motor in the V/F and sensorless (SSL) control mode. In the Vector control mode (VEC), this function is neglected because the power of DC braking will be adapted to the load automatically.

A-20 DC Brake Start Time

- This function is used for setting the DC braking time before start running the motor as seen in figure 15. The value can be set from 0.0~60.0 second.

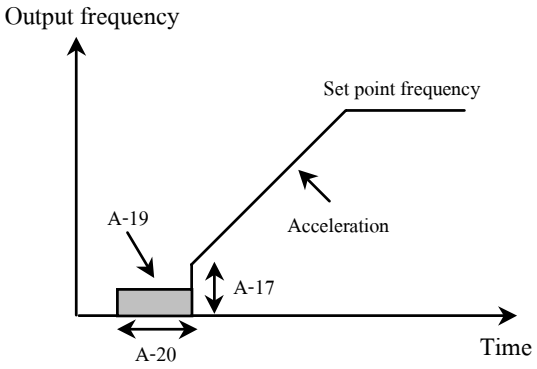


Figure 15 The time and duty of DC braking (Starting time)

A-21 Braking Method

- This function is used to select the braking method

Data	Description
1	Decrease speed until reaching the stop frequency (A-22) and then stop.
2	Decrease speed until reaching the stop frequency (A-22) and then stop the motor by DC braking. (More details in function A-23 and A-24)
3	Stop control immediately and let the motor free running as shown in figure 16

A-22 Stop Frequency

- This function is used for setting the stop frequency as shown in figure 16. The value can be set from 0.00 ~ 50.00 Hz in the vector control mode (VEC) or 0.50 - 50.00 Hz in the V/F and sensorless control (SSL) mode.

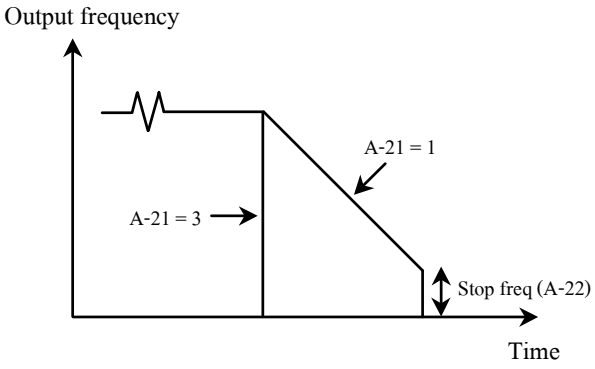


Figure16 Stop frequency

Remark:

- If the stop frequency (A-22) is higher than the start frequency (A-17), the inverter can be start only when the set point frequency is more than or equal to the stop frequency.

A-23 DC Brake Stop Duty

- This function is used for setting the power (duty) of DC braking after the inverter stop controlling the motor as seen in figure 17. The value can be set from 1~100% of the rated current of motor in the V/F and sensorless (SSL) control mode. In the Vector control mode (VEC), this function is neglected because the power of DC braking will be adapted to the load automatically.

A-24 DC Brake Stop Time

- This function is used for setting the DC braking time after the inverter stop controlling the motor as seen in figure 17. The value can be set from 0.0~60.0 second.

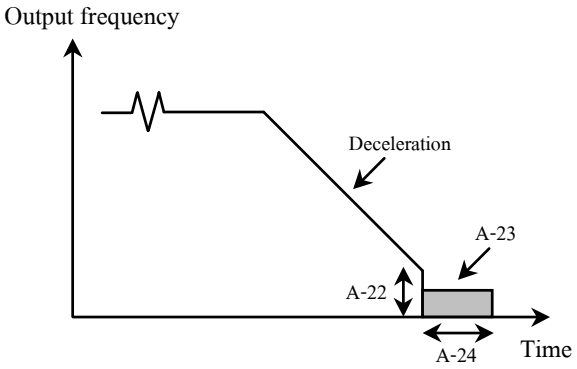


Figure 17 The time and duty of DC braking (Stop time)

A-25 Switching Frequency

- This function is used for setting the switching frequency of inverter from 1~15 kHz.

Remark:

- Increasing the switching frequency leads to lower noise, however it will be more switching loss and leakage current.

A-26 Factory Setting

Data	Description
0	Use the changed value/Unlock function.
1	Use the factory setting from A – 00 to E –14
2	Lock function

MULT-STEP FUNCTIONS

B-00 2nd Acceleration Time	**B-01 2nd Deceleration Time**
B-02 3rd Acceleration Time	**B-03 3rd Deceleration Time**
B-04 4th Acceleration Time	**B-05 4th Deceleration Time**
B-06 5th Acceleration Time	**B-07 5th Deceleration Time**
B-08 6th Acceleration Time	**B-09 6th Deceleration Time**
B-10 7th Acceleration Time	**B-11 7th Deceleration Time**
B-12 8th Acceleration Time	**B-13 8th Deceleration Time**
B-14 Jog Acceleration Time	**B-15 Jog Deceleration Time**

- In the speed control and PID control mode, the function B–00 to B-15 are used for setting the linear acceleration and deceleration times of the 2nd–8th speed commands and the jog speed command in the function B–23 to B–30 as seen in figure 18. The value can be set from 0.0 ~ 600.0 second.
- In the torque-control mode (TRQ), these functions are used for setting the linear acceleration and deceleration times for the 2nd–8th torque commands and also the 9th torque command (Jog) in function B-37 to B-44.

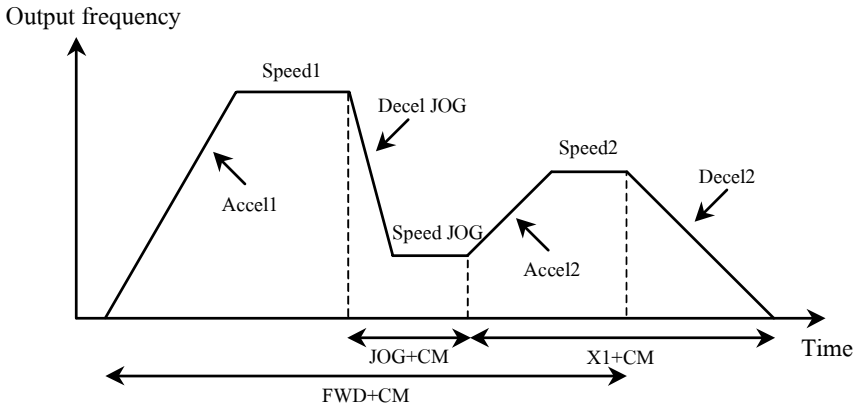


Figure 18 Acceleration and deceleration time for Multi–speed operation

B-16 Soft Acceleration Time

B-17 Soft Deceleration Time

- In the speed control and PID control mode, the function B–16 and B-15 are used for setting the soft acceleration and deceleration time of every speed commands for the soft operation that can be activated by the CM-SOFT connection as seen in figure 19. The value can be set from 0.0~6000.0 second.
- In the torque-control mode (TRQ), these functions are used for setting the soft acceleration and deceleration time of every torque commands for the soft operation.

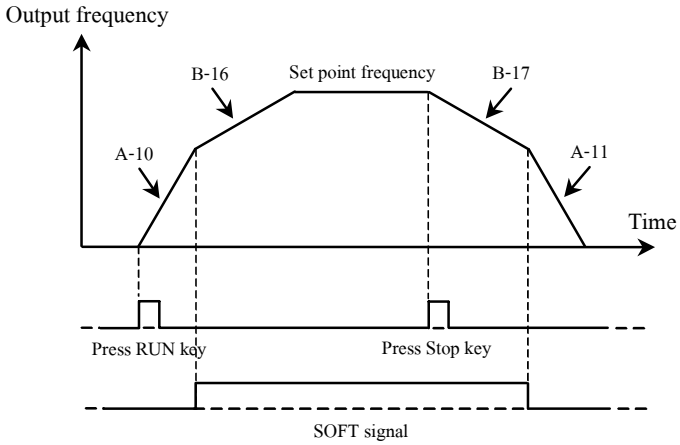


Figure 19 Soft acceleration and deceleration

B-18 S-Curve Acceleration Start Time	B-19 S-Curve Acceleration End Time
B-20 S-Curve Deceleration Start Time	B-21 S-Curve Deceleration End Time

- These functions are used for setting the S-curve acceleration and deceleration time from 0.0~6000.0 second. These functions are used together with the linear acceleration and deceleration time in the function A-10, A-11 and B-00 to B-17.
- The time values in these functions are based on 50 Hz which mean that if we set the function B-18 to B-21 to be 5, the motor will be accelerated from 0.00 Hz to 50.00 Hz and decelerated from 50.00 Hz to 0.00 Hz with the 5 second of start and end time interval of s-curve each.
- Because of the 3-part mixing of the acceleration and deceleration time, user can change the pattern of the acceleration and deceleration in 8 styles as seen in figure 20. The setting for all patterns are shown in table 1

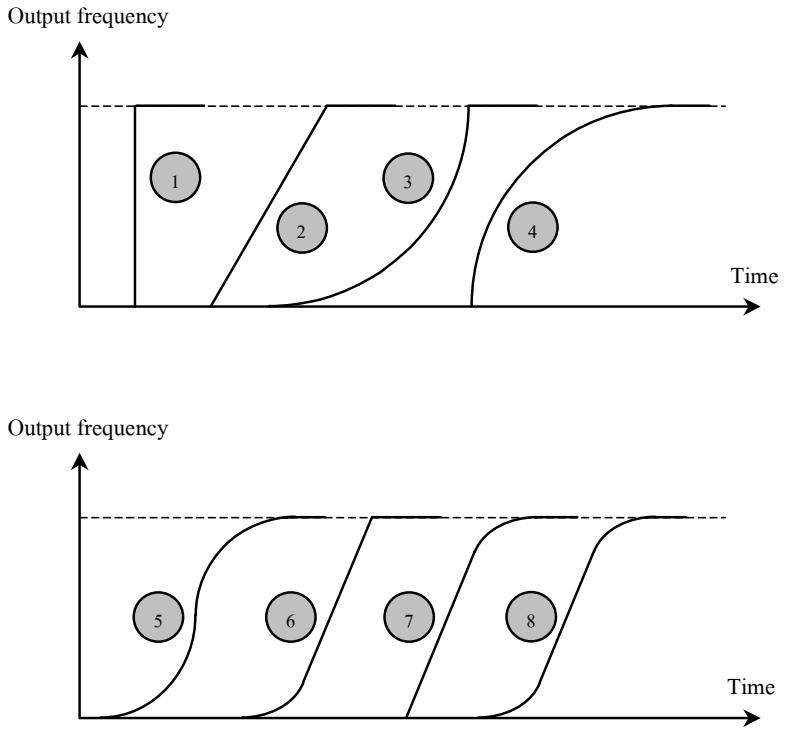


Figure 20 8 patterns of s-curve acceleration and deceleration

Table 1 s-curve setting method

	S-Curve Start Time	Linear ACC&DEC Time	S-Cure End Time
1	X	X	X
2	X	O	X
3	O	X	X
4	X	X	O
5	O	X	O
6	O	O	X
7	X	O	O
8	O	O	O

Example If we set the linear acceleration and deceleration time in function A-10 and A-11 equal to the s-curve acceleration and deceleration time in function B-18 to B-21 at 5 second, the total acceleration and deceleration time between 0.00 Hz and 50.00 Hz are 15 second as shown in figure 21.

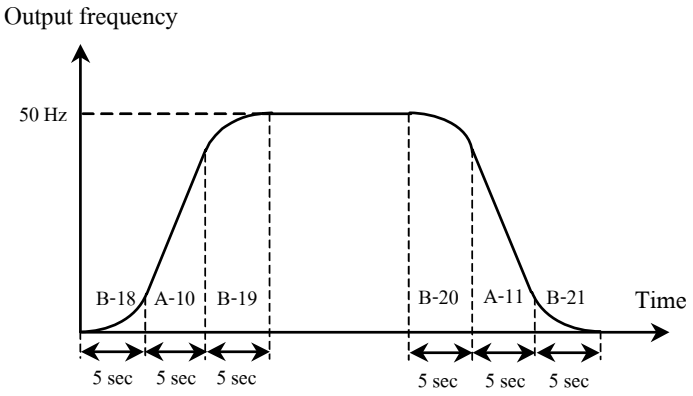


Figure 21 Example of s-curve setting

Remark:

- In the torque-control mode (TRQ), these functions are used for setting the s-curve acceleration and deceleration time of the torque command. In the PID controller mode, these functions are used for setting the s-curve acceleration and deceleration time of the frequency command together with function A-10, A-11 and B-00 to B-17.

B-22 1st Speed Limit: TRQ

B-23 2nd Speed References: SPD / 2nd Speed Limit: TRQ

B-24 3rd Speed References: SPD / 3rd Speed Limit: TRQ

B-25 4th Speed References: SPD / 4th Speed Limit: TRQ

B-26 5th Speed References: SPD / 5th Speed Limit: TRQ

B-27 6th Speed References: SPD / 6th Speed Limit: TRQ

B-28 7th Speed References: SPD / 7th Speed Limit: TRQ

B-29 8th Speed References: SPD / 8th Speed Limit: TRQ

B-30 Jog Speed References: SPD/ 9th Speed Limit: TRQ

- In the speed-control mode, function B-23 to B-30 are used for setting the 2nd-8th speed references and jog speed that can be activated by the connection of X1, X2, X3 or JOG with CM terminal as shown in table 2 and figure 22. The value can be set from 0.00 Hz to 600.0 Hz.
- In the torque-control mode (TRQ), these functions are used for setting the speed limit of the 2nd-8th torque commands and also the 9th torque command (jog command) in function B-37 to B-44.

Table 2 The relation between the command and the X1, X2, X3 and JOG terminal state

	X1	X2	X3	JOG
Command 1st	OFF	OFF	OFF	OFF
Command 2nd	ON	OFF	OFF	OFF
Command 3rd	OFF	ON	OFF	OFF
Command 4th	ON	ON	OFF	OFF
Command 5th	OFF	OFF	ON	OFF
Command 6th	ON	OFF	ON	OFF
Command 7th	OFF	ON	ON	OFF
Command 8th	ON	ON	ON	OFF
Command JOG	ON/OFF	ON/OFF	ON/OFF	ON

Remark:

- The JOG command has first priority as seen in table 2.

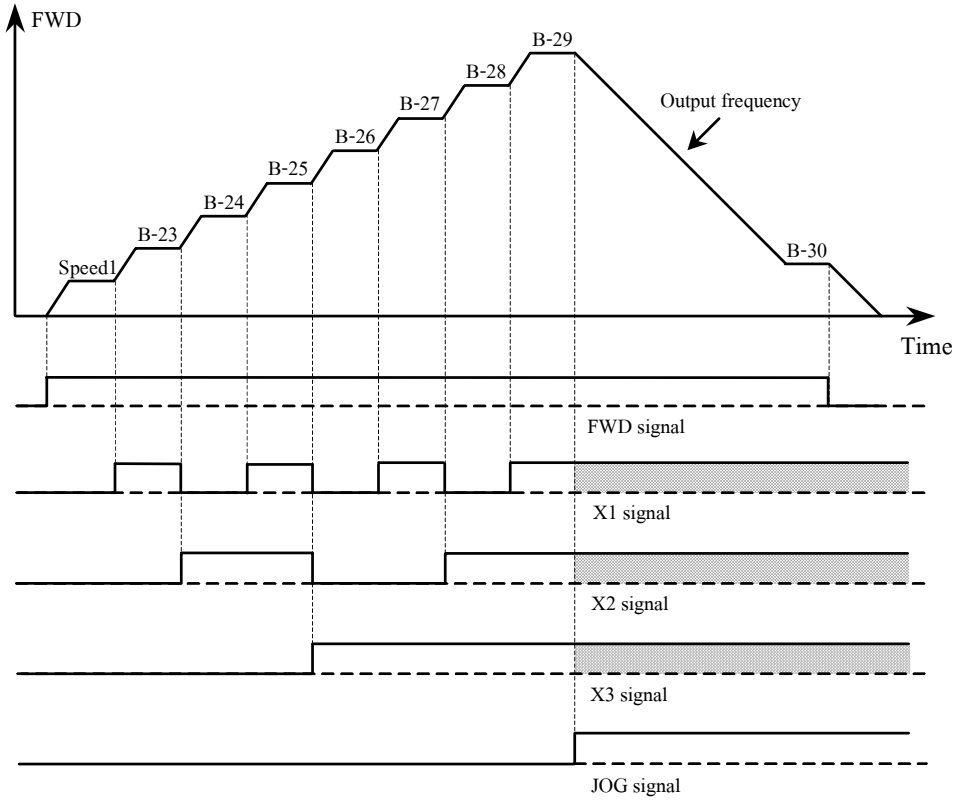


Figure 22 The sequence of multi-speed operation when use the X1, X2, X3 and JOG terminal

B-31 1st Jump Frequency Bottom	**B-32 1st Jump Frequency Top**
B-33 2nd Jump Frequency Bottom	**B-34 2nd Jump Frequency Top**
B-35 3rd Jump Frequency Bottom	**B-36 3rd Jump Frequency Top**

- These functions are used for setting the frequency ranges that we don't want the motor to be operated (jump frequency) for avoiding of the mechanical vibration as seen in figure 23
- The bottom frequency can be set from 0.00 Hz to the top frequency and the top frequency can be set from the bottom frequency to 600.0 Hz.

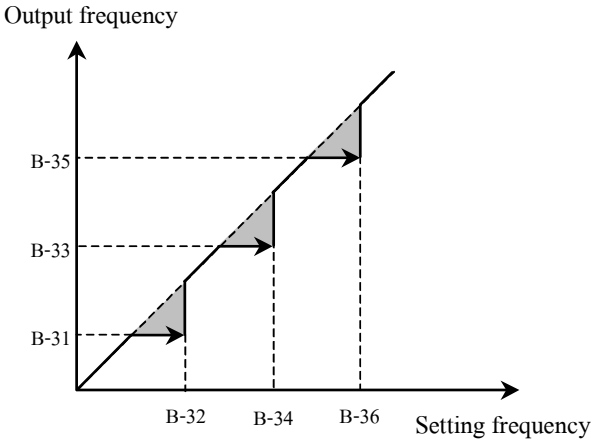


Figure 23 Jump frequency operations

B-37 2nd Torque Reference	**B-38 3rd Torque Reference**
B-39 4th Torque Reference	**B-40 5th Torque Reference**
B-41 6th Torque Reference	**B-42 7th Torque Reference**
B-43 8th Torque Reference	**B-44 Jog Torque Reference**

- These functions are used in the torque-control mode only. The value in function B-37 to B-44 are used as the 2nd-8th torque commands and the 9th torque command (jog command) that can be activated by the connection of X1, X2, X3 or JOG with CM terminal as shown in table 2. The value can be set from 0.0~200.0% of the rated torque of motor.

B-45 PID Reference Acceleration / Deceleration Time

- This function is used in the PID controller mode only. The value in this function is used as the acceleration and deceleration time for the 1st-9th set points. The value can be set from 0.0-60.0 second.

B-46 2nd PID Reference	**B-47 3vc PID Reference**
B-48 4th PID Reference	**B-49 5th PID Reference**
B-50 6th PID Reference	**B-51 7th PID Reference**
B-52 8th PID Reference	**B-53 Jog PID Reference**

- This function is used for setting 2nd-8th set points and also the 9th (jog command) set point as seen in figure 24 that can be activated by the connection of X1, X2, X3 or JOG with CM terminal as shown in table 2. The value can be set from 0.0~100.0% of the rated of sensor.

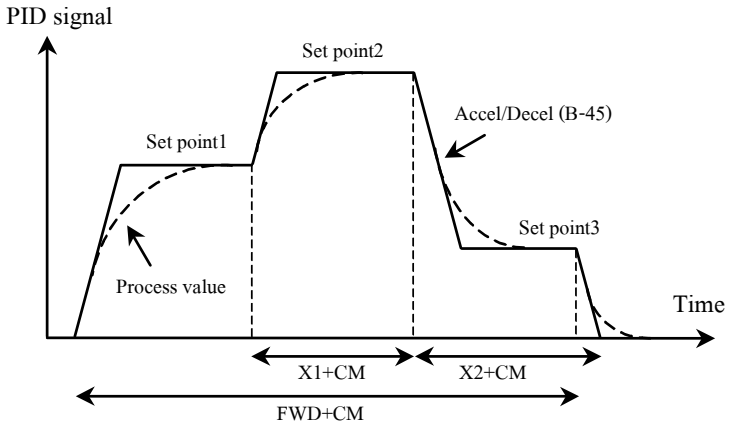


Figure 24 Example of multi-PID set point operation

TERMINAL FUNCTIONS

C-00 Digital Input Terminal I1

C-01 Digital Input Terminal I2

C-02 Digital Input Terminal I3

C-03 Digital Input Terminal I4

C-04 Digital Input Terminal I5

- These functions are used for setting type of the digital input terminals (I1-I5), which can be set as the following table. The setting of each input can't be duplicated.

Data	Description
1	Multi–step frequency 1 (X1)
2	Multi–step frequency 2 (X2)
3	Multi–step frequency 3 (X3)
4	Jog frequency (JOG) selection
5	External reset (RST)
6	Reset hold (RH) for 3 wire operation
7	UP command (UP-Down control method)
8	Down command (UP-Down control method)
9	Soft ACC / DEC selection
10	Free run (FR)
11	External fault (THR)
12	CS for Line change-over operation

C-05 Digital Output Terminal O1

C-06 Digital Output Terminal O2

- These functions are used for setting type of the O1 and O2 output terminal.

Data	Description
1	Start / stop signal (SST1) Out the signal while the motor is running.
2	Start / stop signal with DC brake (SST2) Out the signal while the motor is running including DC braking. (more details in function C-07, C-08)
3	Frequency agreement signal (FAR) Out the signal when the output frequency equals to the set point frequency. (more details in function C-09)
4	Frequency level detection signal (FDT) Out the signal when the output frequency is more than or equal to the specified frequency. (more details in function C-10, C-11)
5	Over load warning signal (OLW) Out the signal when load of motor is more than the detection level set in D-01 and stop out the signal when collective load of motor is less than the detection level as seen figure 25.
6	Inverter magnetic contactor signal (MCI) Out the signal when the inverter starts until ready to transfer the motor to the line or when the inverter controls the motor again with the delay time in function D-09 as shown in figure 27
7	Line magnetic contactor signal (MCL) Out the signal when the inverter transfer the motor to the line with the delay time in function D-08 and stop the signal when the inverter controls the motor again as shown in figure 27

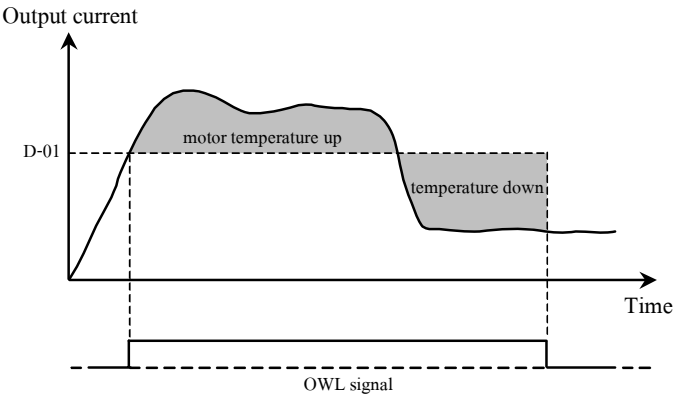


Figure 25 Over load warning signal

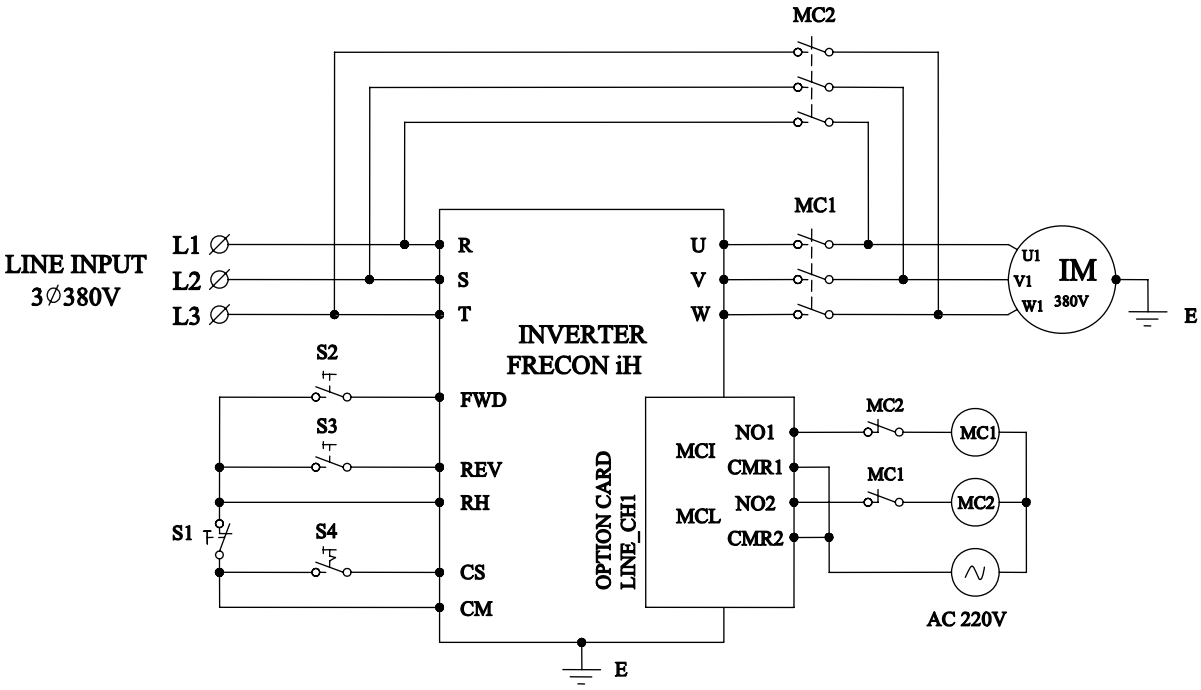


Figure 26 Wiring diagram for the Line change-over operation

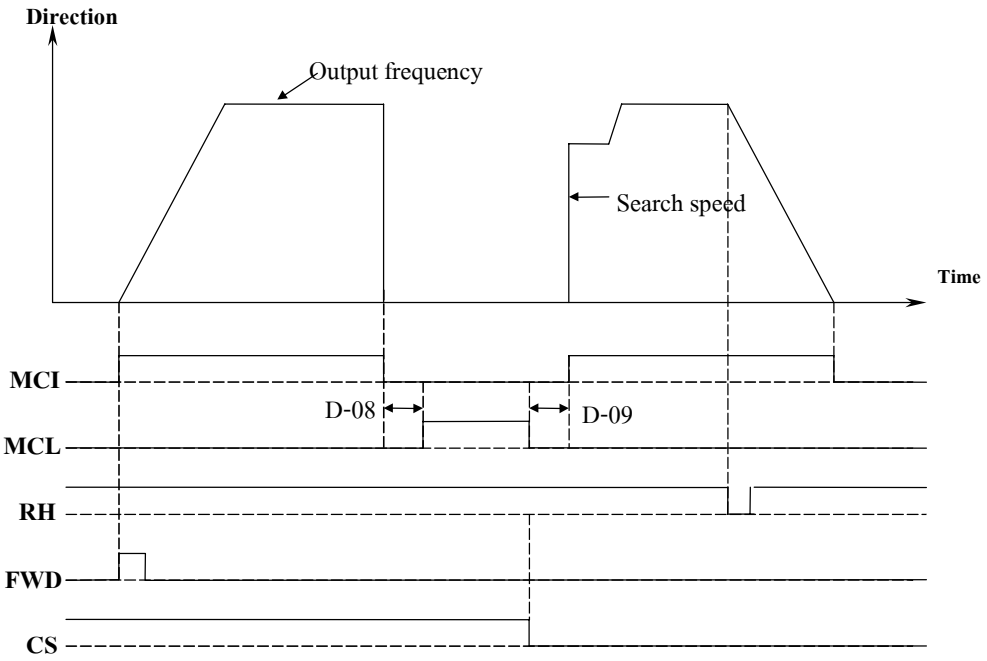


Figure 27 The sequence of the Line change-over operation

C-07 Start Stop Signal (SST2) in DC Brake Start

- This function is used for setting the time delay of SST2 signal when DC brake is activated at the start of running as seen in figure 28. The value can be set from 0~100% of the DC brake start time in function A-20.

C-08 Start Stop Signal (SST2) in DC Brake Stop

- This function is used for setting the time delay of SST2 signal when DC brake is activated at the end of running as seen in figure 28. The value can be set from 0~100% of the DC brake stop time in function A-24.

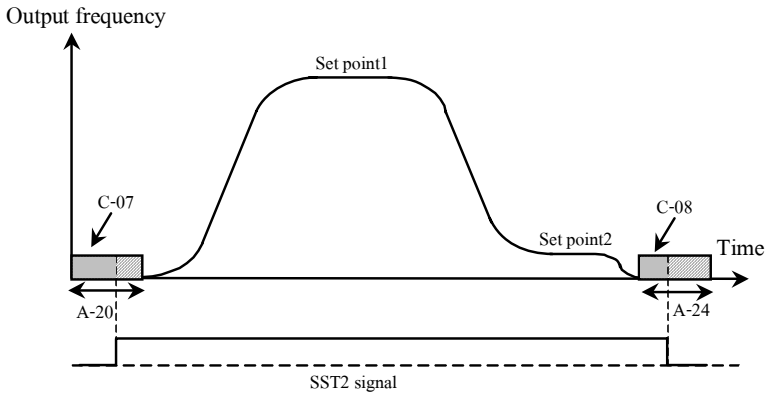


Figure 28 The time delay of SST2

C-09 Frequency Agreement (FAR) Hysteresis

- This function is used for setting the band of hysteresis frequency for calculating the FAR signal as shown in equation (3). This hysteresis band is used for avoiding the fluctuation of FAR signal when the frequency is not steady (in the case of analog command) as seen in figure 29. The value can be set from 0.00~10.00 Hz.

$$(|F_S| - hys_{FA}) \le |F_O| \le (|F_S| + hys_{FA}) \quad \ldots (3)$$

Remark:

- The set point frequency (F_{SP}) using for FAR signal calculation is the 1st-8th frequency command or the jog command depending on the present operation.

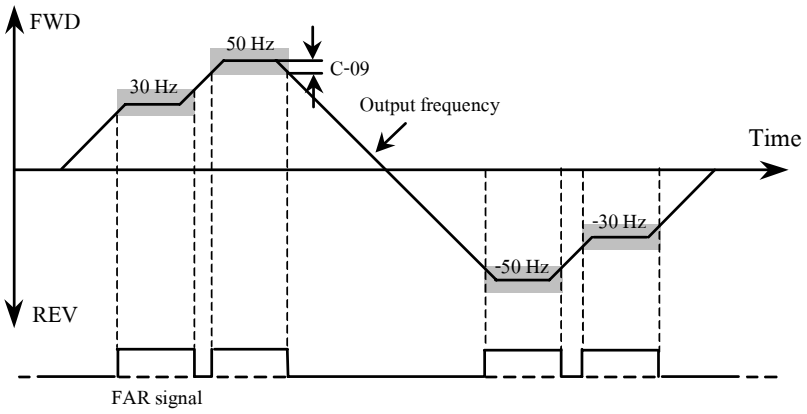


Figure 29 Example of the frequency band setting for FAR signal

C-10 Frequency Detection (FDT) Level

- This function is used for frequency level for the FDT signal calculation as shown in equation (4). The value can be set from 0.00~600.00 Hz.

C-11 Frequency Detection (FDT) Hysteresis

- This function is used for setting the band of hysteresis frequency for calculating the FDT signal as shown in equation (4). This hysteresis band is used for avoiding the fluctuation of FDT signal when the frequency is not steady (in the case of analog command) as seen in figure 30. The value can be set from 0.00~30.00 Hz.

$$\begin{aligned} &FDT\ ON: \ |F_{OUT}| \ \geq \ level_{FDT} \\ &FDT\ OFF: |F_{OUT}| \ \leq \ (level_{FDT} - hyst_{FDT}) \end{aligned} \quad \ldots (4)$$

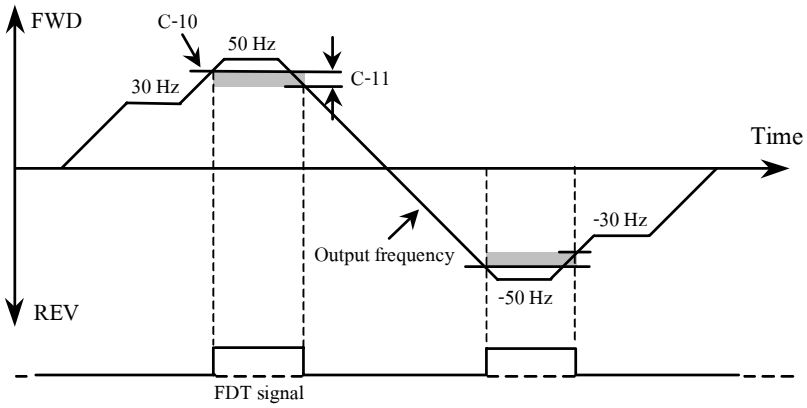


Figure 30 Example of the frequency band setting for FDT signal

C-12 Analog Input Terminal Vi

- This function is used for the Vi terminal's input signal type selection.

Data	Description
1	Voltage: 0~10 Vdc
2	Voltage: -10~+10Vdc (with optional card)
3	Current: 4~20 mA (please see remark)

Remark:

- When changing the input type from voltage to be current, user must connect the RCi (200Ω) and RP25 (200kΩ) resistances on the controller board.

The function C-13 to C-15 are used to calculate the input command from Vi terminal for every command type including speed command (1st speed reference), torque command (1st torque reference) and PID command (1st PID reference) when user set the function A-04 to be 2, 4 and 5 respectively.

C-13 Bias Setting for Vi

- This function is used for setting the bias/offset of the Vi input when the input is 0V (Voltage input) or 4mA (Current input). In the speed-control mode, the value can be set from 0.0 Hz to the gain value in function C-15. In the torque-control and PID controller mode, the value can be set from 0.0% to the gain value in function C-15.

C-14 Direction of Bias Vi

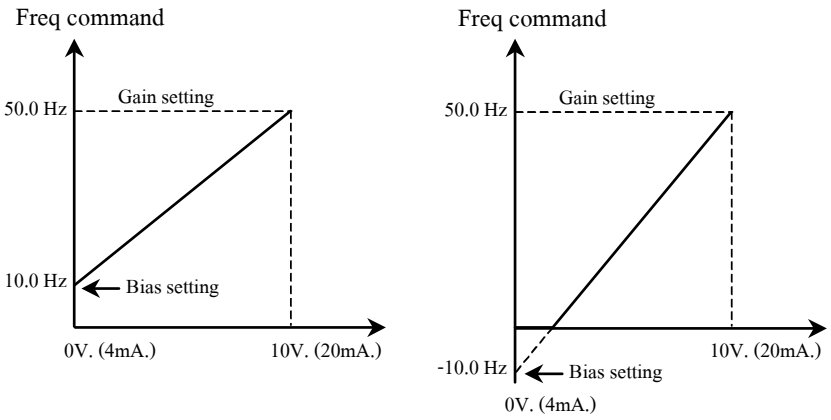
- This function is used for setting the direction (sign) of the Vi bias value.

Data	Description
1	Positive bias (+)
2	Negative bias (-)

C-15 Gain Setting for Vi

- This function is used for setting the gain of Vi input signal when the input is 10V (Voltage input) or 20mA (Current input). In the speed-control mode, the value can be set from the bias value in function C-13 to 600.0 Hz. In the torque-control mode, the value can be set the bias value in function C-13 to 200.0% of the rated torque of motor. And, in the PID controller mode, the value can be set the bias value in function C-13 to 100.0% of the rated of sensor.

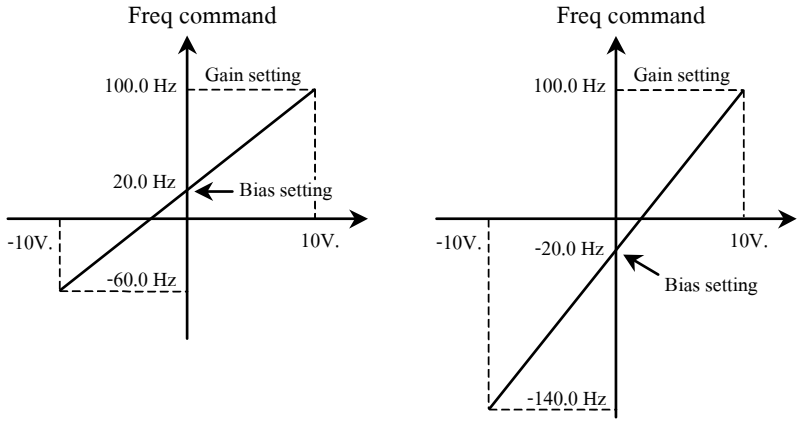
Example Figure 31 shows the input command pattern when using the 0~10V (or 4~20mA) input type and set C-15=50.0 Hz, C-13=10.0 Hz with C-14=1 (31(a)) and 2 (31(b)).



(a) Positive bias (b) Negative bias

Figure 31 Example of the input command pattern when using the 0~10V (4~20mA) input type

Example Figure 32 shows the input command pattern when using the -10~+10V input type and set C-15=100.0 Hz, C-13=20.0 Hz with C-14=1 (32(a)) and 2 (32(b)).



(a) Positive bias (b) Negative bias

Figure 32 Example of the input command pattern when using the -10~+10V input type

C-16 Analog Input Terminal Ci

- This function is used for the Ci terminal's input signal type selection.

Data	Description
1	Voltage: 0~10 Vdc (please see remark)
2	Voltage: -10~+10Vdc (with optional card)
3	Current: 4~20 mA

Remark:

- When changing the input type from voltage to be current, user must remove the R24 (200Ω) and RP26 (200kΩ) resistances from the controller board.

The function C-17 to C-19 are used to calculate the input command from Ci terminal for every command type including speed command (1st speed reference), torque command (1st torque reference) and PID command (1st PID reference) when user set the function A-04 to be 3, 4 and 5 respectively.

C-17 Bias Setting for Ci

- This function is used for setting the bias/offset of the Ci input when the input is 0V (Voltage input) or 4mA (Current input). In the speed-control mode, the value can be set from 0.0 Hz to the gain value in function C-19. In the torque-control and PID controller mode, the value can be set from 0.0% to the gain value in function C-19.

C-18 Direction of Bias Ci

- This function is used for setting the direction (sign) of the Ci bias value.

Data	Description
1	Positive bias (+)
2	Negative bias (-)

C-19 Gain Setting for Ci

- This function is used for setting the gain of Ci input signal when the input is 10V (Voltage input) or 20mA (Current input). In the speed-control mode, the value can be set from the bias value in function C-17 to 600.0 Hz. In the torque-control mode, the value can be set the bias value in function C-17 to 200.0% of the rated torque of motor. And, in the PID controller mode, the value can be set the bias value in function C-17 to 100.0% of the rated of sensor.

Example Figure 33 shows the input command pattern when using the summation of Vi and Ci signal. Given that the Vi pattern is same as the pattern in figure 32(b) and the Ci pattern is same as the pattern in figure 31(a), the input command will be in the shadowed region.

C-20 Analog Input Filter

- This function is used for setting the time constant of the input filter for the Vi and Ci input signal. The value can be set from 0.00~3.00 second.

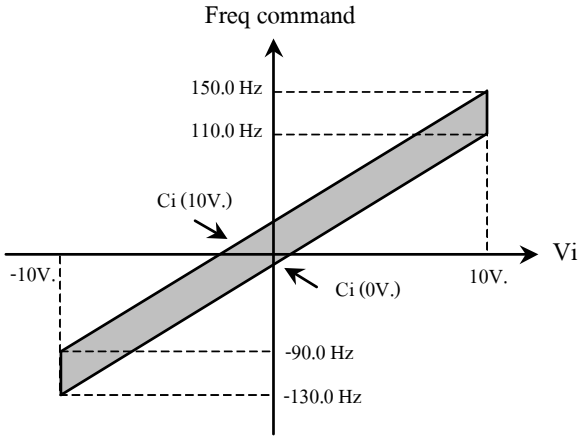


Figure 33 Example of the input command pattern when using the summation of Vi and Ci signal

C-21 Analog Output Terminal AD1

- This function is used for the AD1 terminal's output signal type selection.

Data	Description
1	Voltage: 0~10Vdc
2	Current: 4~20mA (must modify the controller board)

C-22 Analog Output Signal

- This function is used for specified the function of the output signal from AD1 terminal.

Data	Description
1	Output signal shows the set point value depending on the control mode. The 100% duty output represents the maximum frequency as set in A-09 in the speed-control mode or 100.0% of the command value in the torque-control and PID controller mode.
2	Output signal shows the running set point value depending on the control mode.
3	Output signal shows the current of motor. 100% duty for the rated current of inverter.
4	Output signal shows the voltage of motor. 100% duty for the base voltage (A-06).
5	Output signal shows the speed of motor. 100% duty for the maximum frequency (A-09).
6	Output signal shows the torque of motor. 100% duty for the rated torque of motor
7	Output signal shows the power using by motor. 100% duty for the rated power of inverter
8	Output signal shows the DC bus voltage. 100% duty for the maximum DC bus voltage.
9	Output signal shows the feedback signal of the PID controller. 100% duty for the rated of sensor.

C-23 Adjust Analog Output

- This function is used for adjusting the analog output signal at AD1 terminal. It can be used for getting more output resolution or reduction of the output signal. The value can be set from 0~200%.

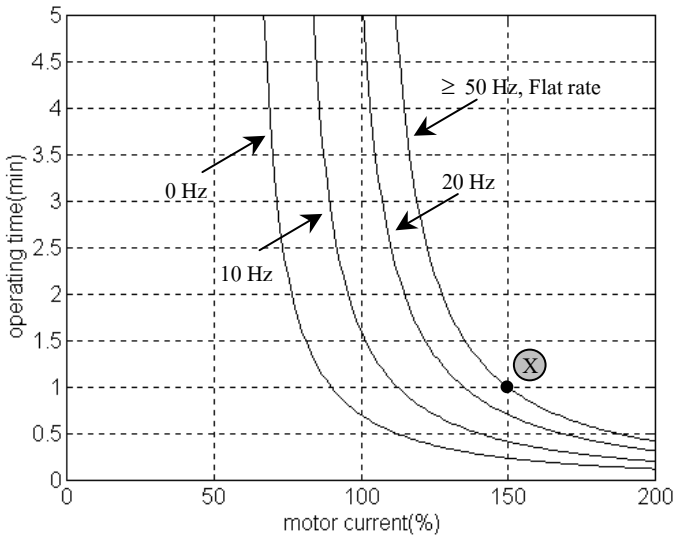
Example Assume that we connect the meter for monitoring the system pressure with the sensor rated at 10 Bar and the AD1 maximum output at 10V. If we always control the pressure within 6 Bar, we can get more resolution by setting C-23 to be 150% making the 9V output from AD1 at 6 bar pressure.

PROTECTIVE FUNCTIONS

D-00 Electronic Thermal Overload

- This function is used for setting the overload protection as follow:

Data	Description
0	Not check overload (For the good heat dissipation motor).
1	Flat rate checking: Consider the motor current only. The relation between the inverter operating time (before trip) and the load (motor current) can be shown in figure 34 by the >=50 Hz line.
2	Derate checking: Take motor current and output frequency into consideration as shown in figure 34. From figure 34, we can see that the overload current decreases with the output frequency because of the bad heat dissipation at low frequency.



Picture 34 Overload current characteristics for derate checking.

D-01 Electronic Thermal Overload Level

- This function is used for setting the current limitation from 20~105 % of the rated current of inverter for the overload checking in the case that the motor has taken the load more than 1.5 times of overload level for 1 minute interval.

Example If we set the function for flat rate checking (D-00) and 100% overload level (D-01), it means that the 1.5 times of overload level is 150% and the motor can take the load as much as this level in 1 minute interval as shown as point X in figure 34. In the case that we set the motor size in E-16 not equal to the inverter size in E-15, the overload level will be adapted to the capacitive of inverter automatically.

D-02 Stall Prevention

- This function is used for setting the inverter's over current and over voltage protection as follow:

Data	Description
0	Not check.
1	Stall the acceleration when the inverter current is more than the value in D-03.
2	Stall the deceleration when the inverter voltage is more than the value in D-04.
3	Stall for both case.

D-03 Stall Prevention Current Level

- This function is used for setting the stall current level as shown in figure 35. The value can be set from 50~200% of the rated current of inverter.

D-04 Stall Prevention Voltage Level

- This function is used for setting the stall voltage level as shown in figure 35. The value can be set from 80~100% of the maximum DC bus voltage of inverter (800V for 380V model and 400V for 220V model).

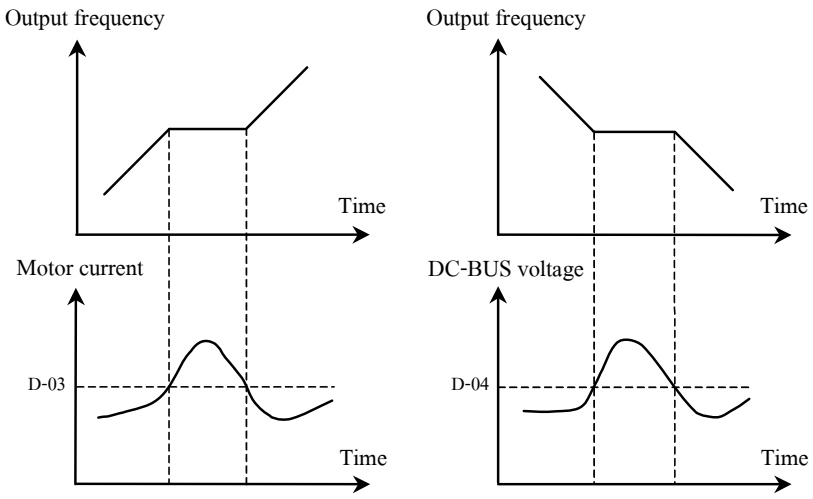


Figure 35 Example of stall operation

D-05 Auto Restart Method

- This function is used for setting the auto restart method after the Line/Main supply is dropped or unavailable when the inverter is running (Run mode).

Data	Description
0	Not Active.
1	Restart from the start frequency (function A-17and A-18).
2	Restart from the starting frequency after the DC braking. This setting can decrease the starting current because the motor is slow down or stop already. (More details in function A-19 and A-20)
3	Start by the search speed technique. This method is good for starting the motor that is still spinning because the inverter will try to apply the matched frequency that making low slip leading to the low starting current.

Remark:

- When the auto restart is active (D-05=1,2 or 3) and the line/main supply is out for a while, inverter will be automatically restarted if the function A-03 is 1 or the inverter still has the external command in the case that function A-03 is 2,3 or 4. In the case of long-time unavailable line/main supply, inverter will be automatically restarted if the inverter still has the external command and the function A-03 is 2, 3 or 4.

D-06 Restart Time

- This function is used for setting the auto restart delay time from 0.0~60.0 second.

D-07 History Fault

- This function is used for keeping the last 4 faults of inverter. The left most is the latest (newest) fault.

5	1	F	9
(i)	(i-1)	(i-2)	(i-3)

Code	1	2	3	4	5	6	7	8	9	A	b	C	d	E	F
Fault	oc_A	oc_b	oc_C	oc_d	-LU-	-OU-	OL-1	OL-2	-PL-	OC-A	OC-b	OC-C	OC-d	-OH-	-En-

D-08 Change Over Interlock Time1

- This function is used for setting the delay time from 0.0~60.0 second before turning the Line Magnetic contactor (MCL) on after the Inverter Magnetic contactor (MCI) is turned off as shown in figure 27. This delay time is used for the short circuit protection between the Line and the inverter output.

D-09 Change Back Interlock Time2

- This function is used for setting the delay time from 0.0~60.0 second before turning the Inverter Magnetic contactor (MCI) on after the Line Magnetic contactor (MCL) is turned off as shown in figure 27. This delay time is used to wait for the reduction of motor's induced voltage before doing search speed.

D-10 Advance Phase Output Voltage

- This function is used for setting the voltage phase angle compensation (in the lead way only) before transfer the motor to the line. The value can be set from 0~360 degree.

D-11 Motor Wiring Protection

- This function is used to activate the checking of the motor connection when running (connection between U, V, W terminal of inverter and the input of motor).

Data	Description
0	Not check.
1	Check connection.

Remark:

- When the checking is active (D-11=1), inverter will trip and show -nC- (No Connect) on the keypad if there is no motor connect to the inverter or the current is less than 5% of the rated current of inverter.

TECHNICAL FUNCTIONS

E-00 Control Mode Selection

Data	Description
1	Speed-control mode (SPD) for the task needing to adjust the speed of motor within 0.00~600.00 Hz
2	Energy-saving speed-control mode.
3	PID controller mode for the close loop control system that control the system via controlling the speed of motor such as pressure control, temperature control etc. The command in this mode can be adjusted within 0.0~100.0 % of the rated of sensor.
4	Energy-saving PID controller mode
5	4 quadrant-type torque-control mode for the task needing to control the torque in the motoring and regenerative region as shown in figure 36(a) such as roller feeder etc. The command in this mode can be adjusted within 0.0~200.0% of the rated of motor.
6	3 quadrant-type torque-control mode for some special torque control task as shown in figure 36(b) and 36(c) such as the electric car driving.

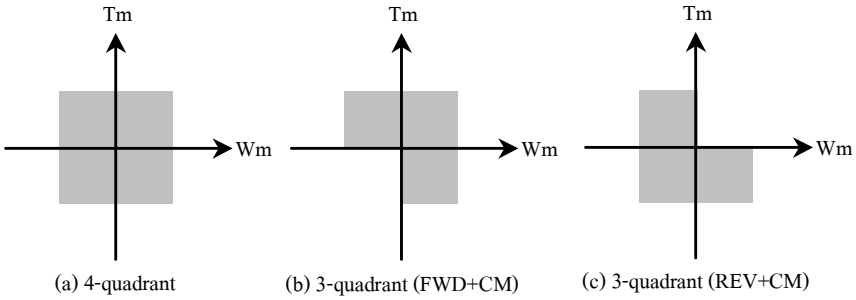


Figure 36 Three and Four quadrant torque-control mode

E-01 Control Method Selection

Data	Description
1	V/F control: Control the motor by adjusting the voltage and frequency of motor.
2	Vector control (VEC): The highest performance control method using the speed sensor (encoder) and needing to know the motor's parameters.
3	Sensorless vector control (SSL): The high performance control method without using the speed sensor (encoder), but still needing to know the motor's parameters.

E-02 Speed Loop Proportional Gain (Kp)

E-03 Speed Loop Integral Time (Ti)

- These functions are used to adjust the gains of speed PI controller as shown in figure 37 for good the speed respond. Kp and Ti an be set from 1~9999.

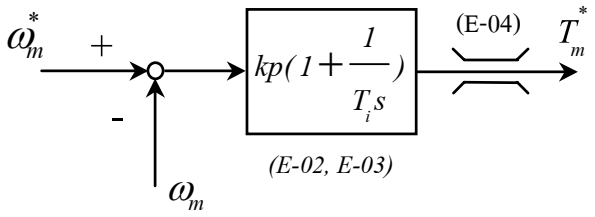


Figure 37 Block diagram of the speed control loop

E-04 Torque Limiter

- This function is used for setting the output torque limit of motor in every mode. The value can be set from 0.0 ~ 200.0% of the rated of motor limit. Figure37 shows the torque limitation scheme.

E-05 PID Controller Feedback

- This function is used for setting the feedback signal input for the PID controller mode, which cannot be duplicated with the function A-04.

Data	Description
1	Receive feedback signal from Vi terminal using the signal details from function C-12 to C-15.
2	Receive feedback signal from Ci terminal using the signal details from function C-16 to C-19.
3	Receive feedback signal from the summation of Vi and Ci signals.

E-06 PID Proportional Band (PB)

E-07 PID Integral Time (Ti)

E-08 PID Derivative Time (Td)

- These functions are used to adjust the gains of PID controller for the good system response as shown in figure 38. The output of PID controller or the frequency command will be limited by the minimum and maximum frequency in function A-08 and A-09 respectively.

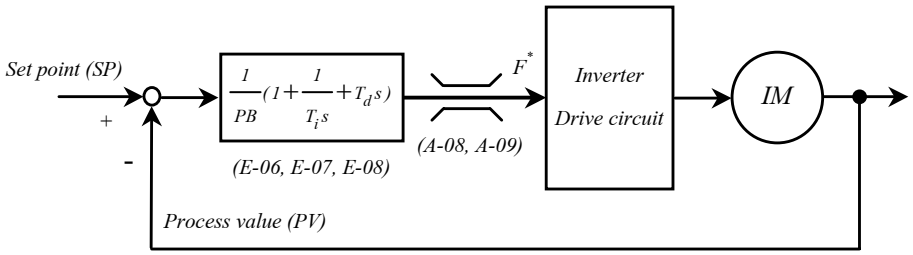


Figure 38 Block diagram of the PID controller system

- Proportional band (PB) is used for increasing or decreasing the response of the system. If PB is too high, the system response will be slow, but if PB is too low the response of system may oscillate. The value can be set from 0.1~1000.0%.
- Integral time (Ti) is used for the steady state error (or offset) cancellation. If Ti is too high, the system response will be slow, but if Ti is too low the response of system may oscillate. The value can be set from 0.0~600.0 second.
- Derivative time (Td) is used for boosting the feedback signal response. If Td is too high, the system response may oscillate. This parameter responses to the differential of the feedback signal, thus it's not recommended to use this parameter with the noisy or fast system. The value can be set from 0.0~60.0 second.

Remark:

- PI controller is normally using for the fast process such as pressure control, while PID controller is using for the slow process such as temperature control.

E-09 PID Control Action

Data	Description
1	Forward action: The output frequency will be increased when the system error (SP-PV) is negative and decreased when the system error is positive. The example process using this style of action is the temperature control in the cooling system.
2	Reverse action: The output frequency will be increased when the system error (SP-PV) is positive and decreased when the system error is negative. The example process using this style of action is the pressure control in the pump system.

E-10 Pulse of Encoder

- This function is used for setting the number of encoder's pulse (for vector control mode). The value can be set from 1~9999 pulses/rev.

E-11 Rated Motor Speed

- This function is used for setting the rated speed of motor specified by the motor's name plate. The value can be set from 1~9999 rpm.

E-12 No Load Current

- This function is used for setting the no-load current of motor. The value can be set from 1~100 % of the rated current of inverter.

E-13 Rated Motor Current

- This function is used for setting the rated current of motor specified by the motor's name plate. The value can be set from 1~200 % of the rated current of inverter.

Example Assume that we use the 5 HP inverter, which has the rated current at 9A, to drive the 3 HP motor, which has the rated current at 5.2A and the no-load current at 2.5A. We can calculate the value for function E-12 and E-13 as follow:

sol^{n} E–12 = (2.5*100)/9 = 28 %

E–13 = (5.2*100)/9 = 58 %

E-14 Auto Tuning Parameters

- This function is used for setting the automatic motor's parameters identification/tuning method.

Data	Description
0	Not active.
1	Running method: This method can be applied when the motor is no-load only. In tuning process, the motor will be run to the first speed command (as shown on keypad) with the torque boosting as set in function A-12,A-13 and the acceleration and deceleration time as set in function A-10 ,A-11 and B-18 to B-21.
2	Stand-still method: This method can be applied whenever the motor is loaded or not.

Before activate the auto tuning process, we must set the following functions:

- Pole pair in function A-02
- Base voltage and Base frequency in function A-06 and A-07
- Pulse of Encoder in function E-10
- Rated motor current in function E-13

The parameters that are obtained after the auto tuning process are:

- No-load current in function E-12
- Dead time in function E-19
- Current loop proportional and integral gain in function E-21 and E-22
- Rs, Rr, σLs, Ls in function E-25 to E-28

E-15 Size of Inverter

E-16 Size of Motor

- These functions are used for setting the size of inverter and motor in the HP unit. For 380V model, the value can be set from 1 HP to 300 HP (P01~P300) and for 220V model, the value can be set from 0.5 HP to 50 HP (0.5HP~50HP)

Remark:

- When changing the values in these functions, the function E-18 to E-28 will be changed to the factory setting values.

E-17 Voltage Scaling

- This function is used as the scale of the output voltage, which should be specified by the input line voltage of inverter. The value can be set from 80~240V for 220V model or 200~460V for 380V model.

E-18 Current Scaling

- This function is used as the scale of the output current, which can be set from 1~9999.
- Normally, when the function E-15 or E-16 Is set, inverter will estimate this scale automatically. If user wants to fine tune this scale, user should try to adjust this scale until the current showing on the keypad equal to the current of motor.

E-19 Dead Time Compensation

- This function is used to compensate the dead time of inverter. The effect of dead time is increasing with the switching frequency and the size of inverter. The value can be set from 0~100% of 6.25 μsec.

E-20 DC Bus Compensation

- This function is used to select the value of DC bus voltage for the output voltage calculation in the V/F control mode.

Data	Description
1	Use the detected DC bus voltage.
2	Use the constant voltage at 310V for 220V model or 540V for 380V model.

E-21 Current Loop Proportional Gain (Kp)

E-22 Current Loop Integral Time (Ti)

- This function is used to adjust the gains of the current PI controller as shown in figure 39 for the good current response. Kp and Ti can be set from 0~9999.

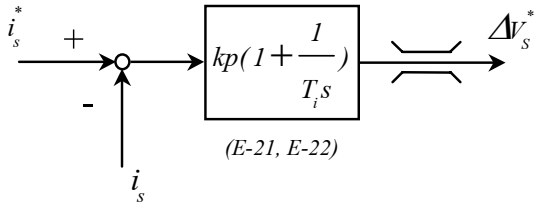


Figure 39 Block diagram of the current controller loop

E-23 Adaptive Proportional Gain (Kp)

E-24 Adaptive Integral time (Ti)

- This function is used to adjust the gains of the PI controller using in the speed estimation part of the sensorless control (SSL) system as shown in figure 40 for the good speed response. Kp and Ti can be set from 0~9999.

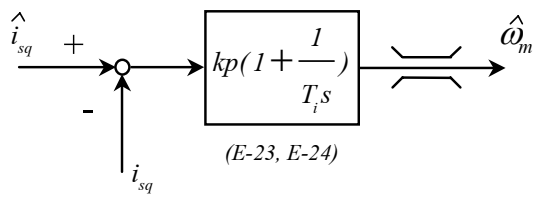


Figure 40 Block diagram of the speed estimation part

E-25 Stator Resistance (Rs)

E-26 Rater Resistance (Rr)

E-27 Leakage Inductance (σLs)

E-28 Stator Inductance (Ls)

- This function is used for setting the parameters of motor including Rs, Rr, σLs, Ls using in the vector control (VEC) and sensorless control (SSL) mode. The value can be set from 1~9999.

Remark:

- The factory settings of these parameters are the values of the standard 220V/380V-50Hz-4pole motor. If user's motor has the different parameters, user should identify the values of parameter by using the auto tuning in function E-14 before running.

E-29 Torque Filter/ Current Filter

- In IH3.L version, this function is used for setting the time constant of the torque filter. Another version, this function is used for setting the time constant of the current noise filter. The value can be set from 1~256. (small value setting gives the large time constant)

E-30 Inverter Version

- This function shows the version of inverter such as IH3.1

RS485 MODBUS RTU COMMUNICATION

The FRECON iH inverter has ability to communicate with the MODBUS RTU protocol via the RS485 communication link, which is one of the favorite industrial communications. This ability lets the user to access the function value of inverter and command the inverter easily.

7.1 Specification of the communication

The communication specification of the FRECON iH inverter can be shown as in table 1.

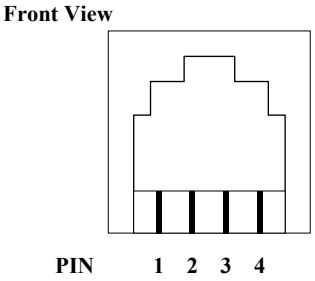
Table 1 specification of the communication

Topic	Detail
Physical layer	RS485
Communication length	<=500m *
Number of connected device	32
Baud rate	2400,4800,9600,19200 bps
Protocol	MODBUS RTU

* ***Remark:*** *The maximum of communication length depends on the baud rate, the link condition and the working environment.*

7.2 Communication terminal

The detail of the communication terminal is shown in figure 1.



Pin	Description
1,4	Ground
2	Tx/Rx+
3	Tx/Rx-

Figure 1 Details of the communication terminal

7.3 Communication wiring

The communication system must be wiring by the 2-line cable connected in the daisy-chain or multi-drop style as shown in figure 2. It's recommended to use the shielded cable for noise reduction and may connect the termination resistor, which has the value matching to the cable (normally 120Ω), at the beginning and the end of the communication line if necessary (the communication link is quite long).

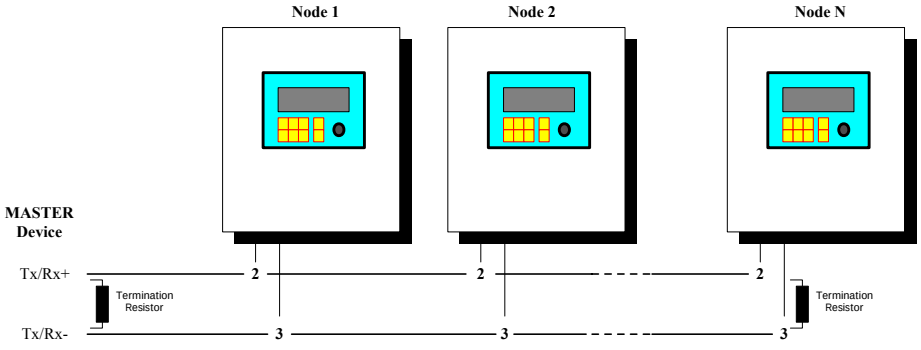


Figure 2 Communication wiring diagram

7.4 Functions of inverter using for the communication setting

The functions of inverter using in the communication setting are shown in table 2.

Table 2 Functions of inverter using in the communication setting

Function	Name	Description	Data
A-03	Operation Mode	Select the operation mode	5: Operation via communication
A-04	Command Selection	Select the set point/command type	7: Command the set point via the communication
C-24	Node Address	Set the node address of inverter. If "0" is selected, the inverter will be acted as the Master node, which always sending the command value out to the communication line	0: Master Mode 1-247: Slave Mode
C-25	Baud Rate	Set the baud rate	1=2400bps; 2=4800bps; 3=9600bps; 4=19200bps
C-26	Data Format	Set the data format in the form of data length-parity-Stop bit	1=8-N-1; 2=8-N-2; 3=8-E-1; 4=8-O-1
C-27	Reply Interval	Delay time before the inverter sends reply to Master node	0.00-1.00s (min. unit=10ms)
C-28	Communication Loss Time out	The time interval using for identify the lost of communication. "0" for not active.	0.0-60.0s (min. unit=100ms)
C-29	Time out Action	Select the action when loss of communication	0=No Action; 1=Decel; 2=Stop

Function	Name	Description	Data
C-30	Digital Ratio Multiplier	Set the multiplier for the command receiving from the communication	1-9999
C-31	Digital Ratio Divisor	Set the divisor for the command receiving from the communication	1-9999

Remark: *The set point value of the slave inverter can be calculated as follow:*

Set point = [Set point (from Master) x (C-30)]/(C-31)

7.5 The supported MODBUS function

The FRECON iH inverter supports three MODBUS functions:

- **Function 3 (Read Holding Registers):** using for reading the registers that can read maximum 255 registers in the continuous address at one time. In the FRECON iH inverter, the maximum 54 registers can be read (when reading function B-00 to B-53).
- **Function 6 (Preset Single Register):** using for writing one register at a time.
- **Function163 (Preset Multiple Registers):** using for writing maximum 8 registers in the continuous address at one time.

The MODBUS functions expressed above will be used to read/write the function and register of inverter by the address that will be described later. The address using in the FRECON iH inverter is beginning from 0 (0-based). If user wants to use the inverter with the master using the address starting from 1 (1-based), user must add one to the address that specified in this manual. For example, if we want to access function A-19, which is at the address 19 (0-based), we must access the address 20 (=19+1) when using the 1-based address master node instead.

7.6 Functions and Registers that can be accessed via the communication

We can read/write the functions of inverter by accessing the following address:

1. **Function A00-A26** : Address 0-26
2. **Function B00-B53** : Address 100-153
3. **Function C00-C31** : Address 200-231
4. **Function D00-D11** : Address 300-311
5. **Function E00-E29** : Address 400-430

Remark: *Function D0, E14-E18 and E30 cannot be written via MODBUS, but still be readable.*

In addition of the function reading and writing, we can access some special registers, which can be accessed via MODBUS only, as follow:

- **Registers that can be read/written** : There are four registers:

1. **Inverter Command (Address: 1408)**: Using for operating the inverter via the communication. This register has the effect only when the function A-03 is 5. The detail of this register is shown in table 3.
2. **Frequency Reference (Address: 1409)**: Using for setting the set point frequency of inverter. The commanded value must be multiplied by 100 and the result is within 0-60000. For example, if we want to set the set point frequency to be 40.25 Hz, we must send the command as 4025. This register has the effect only when the function A-04 is 7 and the inverter is set to operate in the speed-control mode.

3. **Torque Reference (Address: 1410)**: Using for setting the set point torque of inverter. The commanded value must be multiplied by 10 and the result is within 0-2000. For example, if we want to set the set point torque to be 34.5%, we must send the command as 345. This register has the effect only when the function A-04 is 7 and the inverter is set to operate in the torque-control mode.
4. **PID Reference (Address: 1411)**: Using for setting the set point of PID controller of inverter. The commanded value must be multiplied by 10 and the result is within 0-2000. For example, if we want to set the set point of PID controller to be 34.5%, we must send the command as 345. This register has the effect only when the function A-04 is 7 and the inverter is set to operate in the PID controller mode.

Table 3 Detail of Inverter Command register

Register	Bit	Name	Description
Inverter Command (1408)	1,0	Run/Stop	01=FWD,10=REV, 00/11=STOP
	2	I1	1=I1 Active, 0=I1 Not Active
	3	I2	1=I2 Active, 0=I2 Not Active
	4	I3	1=I3 Active, 0=I3 Not Active
	5	I4	1=I4 Active, 0=I4 Not Active
	6	I5	1=I5 Active, 0=I5 Not Active
	7-15	-	Reserved

- **Read only (MODBUS Function 3) Registers**: There are 11 registers:

1. **Terminal Status (Address: 1416)**: Using for display the terminal status. The register's detail is shown in table 4.
2. **Work Status (Address: 1417)**: Using for display the working status of inverter. The register's detail is shown in table 5.
3. **Trip Status (Address: 1418)**: Using for display the trip status. The register's detail is shown in table 6.
4. **Set Point (Address: 1419)**: Using for display the set point value. The scaling of this register depends on the inverter control mode:
   - Speed-control mode: The scaling is 100: 1 Hz. For example, we can read "4560" when the frequency is 45.60 Hz.
   - Torque-control and PID controller mode: The scaling is 10 = 1 %. For example, we can read "245" when the set point value is 24.5%.

5. **Set Point Run (Address: 1420)**: Using for display the running set point of the inverter. This register has the same scaling as the set point register.
6. **Speed (Address: 1421)**: Using for display the speed of motor in the RPM unit (+/-).*
7. **Iline (Address: 1422)**: Using for display the current of motor. The scaling of this register 10 = 1 A. For example, we can read "125" when the current is 12.5 A.
8. **Vline (Address: 1423)**: Using for display the line-to-line RMS voltage of motor in the Volt unit.
9. **Vlink (Address: 1424)**: Using for display the DC bus voltage of inverter in the Volt unit.
10. **Power (Address: 1425)**: Using for display the estimated power using by motor. The scaling of this register 100 = 1 kW. For example, we can read "125" when the power is 1.25 kW. (+/-)*
11. **Torque (Address: 1426)**: Using for display the estimated torque of motor in the Nm unit. (+/-)*

***Remark:** (+/-) means that the reading value can be positive or negative. The real value is negative when the display value is more than 32767. We can calculate the real value by equation <real value=display value-65536>. For example, If we can read the speed register as "65495", the real value is 65495-65536 = -41 RPM.*

Table 4 Detail of Terminal Status register

Register	Bit	Terminal	Description
Terminal Status (1416)	0	FWD	1=Active, 0=Not Active
	1	REV	1=Active, 0=Not Active
	2	I1	1=Active, 0=Not Active
	3	I2	1=Active, 0=Not Active
	4	I3	1=Active, 0=Not Active
	5	I4	1=Active, 0=Not Active
	6	I5	1=Active, 0=Not Active
	7	-	Reserved
	8	NC	1=Active, 0=Not Active
	9	NO	1=Active, 0=Not Active
	10	O1	1=Active, 0=Not Active
	11	O2	1=Active, 0=Not Active
	12-15	-	Reserved

Table 5 Detail of Work Status register

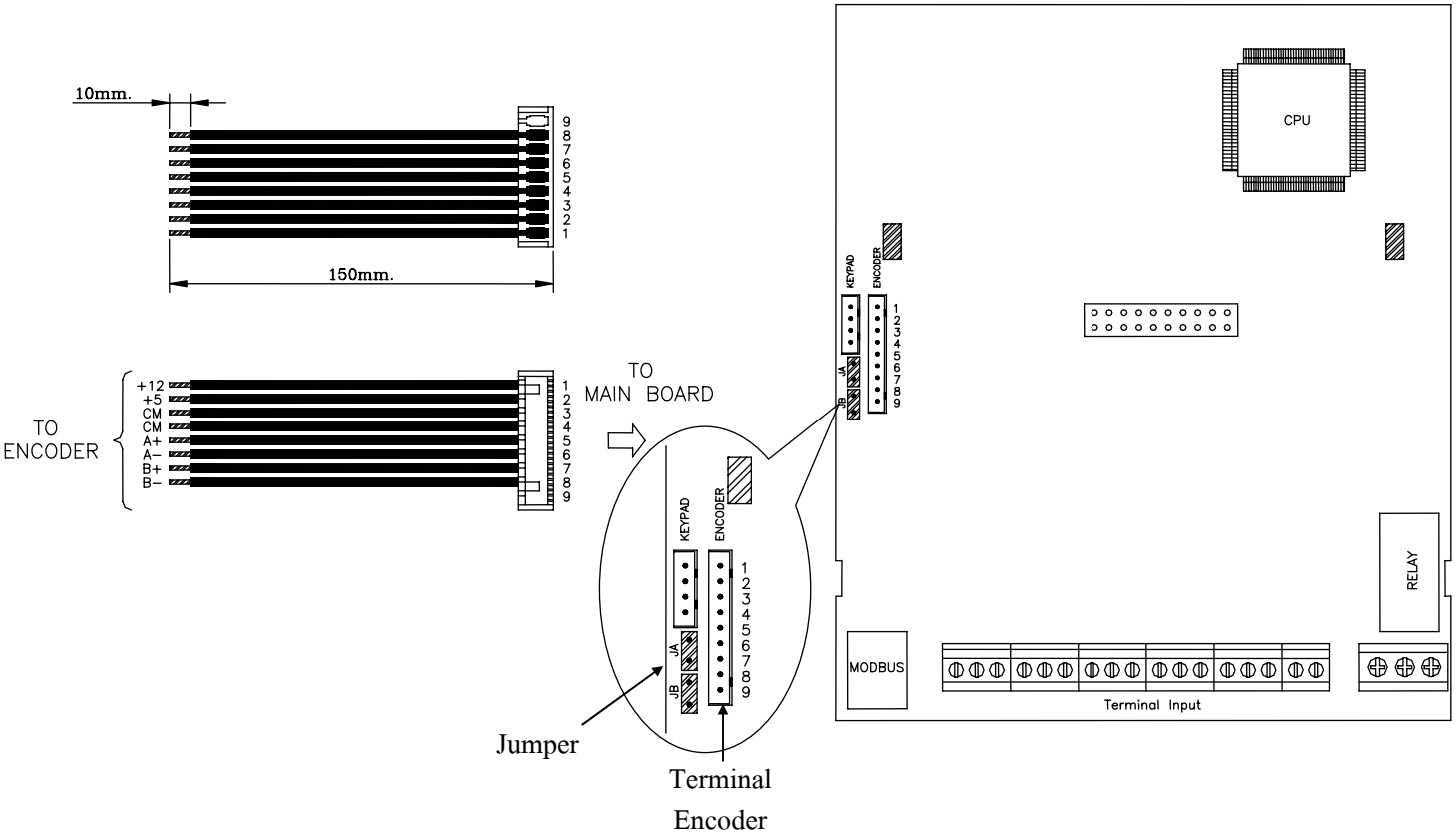
Register	Bit	Name	Description
Work Status(1417)	1,0	Run/Stop	01=FWD,10=REV, 00/11=STOP
	2	TRIP	1=Trip, 0=No Trip
	3	SPEED1	1= Speed1 Active, 0=Speed1 Not Active
	4	SPEED2	1= Speed2 Active, 0=Speed2 Not Active
	5	SPEED3	1= Speed3 Active, 0=Speed3 Not Active
	6	SPEED4	1= Speed4 Active, 0=Speed4 Not Active
	7	SPEED5	1= Speed5 Active, 0=Speed5 Not Active
	8	SPEED6	1= Speed6 Active, 0=Speed6 Not Active
	9	SPEED7	1= Speed7 Active, 0=Speed7 Not Active
	10	SPEED8	1= Speed8 Active, 0=Speed8 Not Active
	11	JOG	1= Jog Active, 0=Jog Not Active
	12	State	1=Steady State, 0=Transient
	13	DC Brake	1=DC Brake Active, 0=DC Brake Not Active
	14	ACCEL	1=In Accel. State, 0=Not in Accel. State
	15	DECEL	1=In Decel. State, 0=Not in Decel. State

Table 6 Detail of Trip Status register

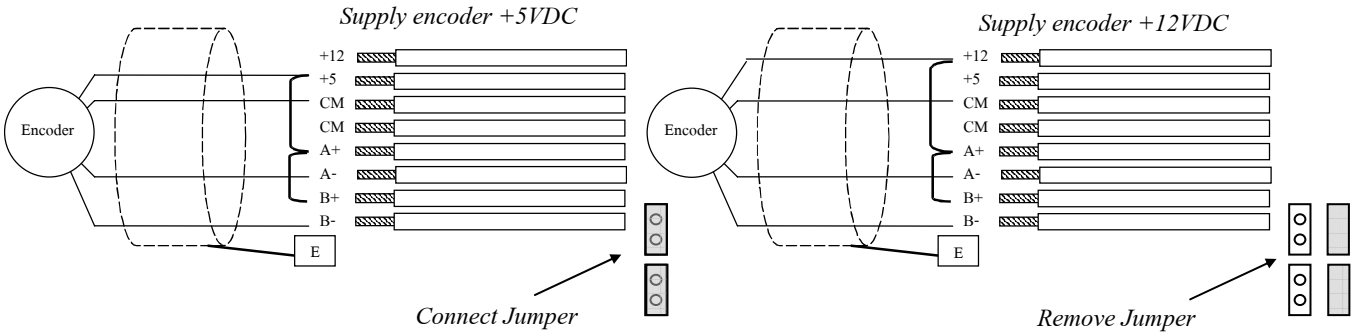
Register	Value	Description
Trip Status(1418)	0	No trip
	1	oc_A
	2	oc_b
	3	oc_C
	4	oc_d
	5	-LU-
	6	-OU-
	7	OL-1
	8	OL-2
	9	-PL-
	10	OC-A
	11	OC-b
	12	OC-C

Register	Value	Description
Trip Status(1418)	13	OC-d
	14	-OH-
	15	-En-
	16	Err1
	17	Err2
	18	Reserved
	19	Err3
	20	-tO-
	21	-nC-

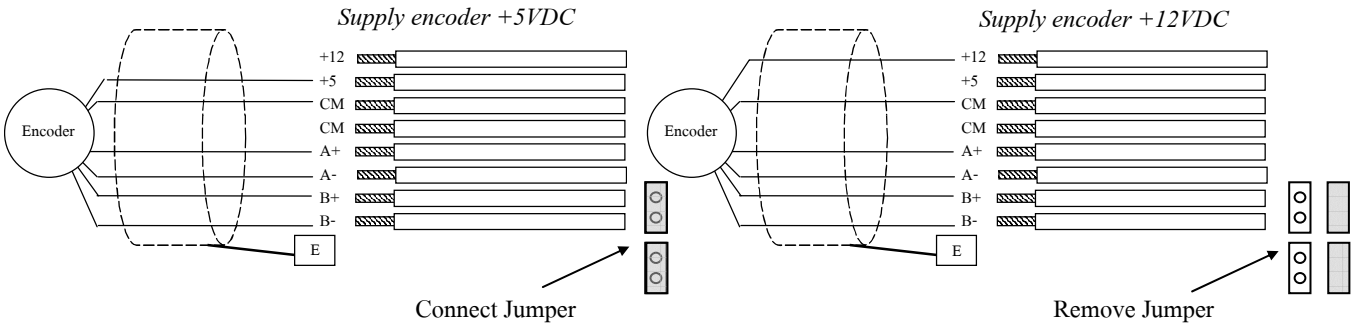
ENCODER WIRING



8.1 Open Collector Type Encoder (4 wire)



8.2 Line Driver Type Encoder (6 wire)



MAINTENANCE AND INSPECTION

9.1 Precautions for maintenance and inspection

For some short time after the power is switched off, a high voltage remains in the smoothing capacitor. Start the inspection at least 5 minutes for inverters rated at 30 HP or less. Wait at least 10 minutes for inverters rated at 40 HP or more. Check that the voltage across the main circuit terminals P-N of the inverter is 25V or less.

9.2 Daily inspection

During operation, a visual inspection for abnormal operation can take place externally without removing the covers. The inspection should cover the following areas:

1) The performance, according to standard specifications, is as expected.
2) The environment conforms to standard specifications.
3) The keypad panel display is normal.
4) There are no abnormal sounds, vibrations, or odors.
5) There are no indications of overheating or discoloration.

9.3 Periodic inspection

Use the following table as your inspection guide.

Component	Check	Corrective action
External terminals, connectors, unit mounting bolts etc.	Loose screws	Tighten
Cooling fins	Build-up of dust and dirt	Blow with dry compressed air
Printed circuit board	Accumulation of conductive dust or oil.	Blow with dry compressed air. If dust and oil can not be removed, replace the board
Cooling fan	For abnormal noise and vibration. Whether the cumulative operation time exceeds 20,000 hours or not.	Replace the cooling fan
Power elements	Accumulation of dust and dirt	Blow with dry compressed air
Smoothing capacitor	Discoloration or odor	Replace the capacitor or inverter unit

TROUBLESHOOTING

1) When the inverter detects a fault, the fault is displayed on the keypad and activates the fault contact output and the motor coasts to stop. Check the cause in the table below and take the corrective actions.
2) If the inspections or corrective actions described cannot solve the problem, please contact your FRECON representative immediately.
3) To restart, turn on the reset input signal or press reset key or shut off the main circuit power supply once, to reset the stop status.

Fault	Description	Corrective action
OC-A / oc_A	● Over current or output short circuit during speed acceleration	1. Check the same as OC-C / oc_C 2. Extend acceleration time (A-10)
OC-b / oc_b	● Over current or output short circuit during DC braking operation	1. Check the same as OC-C / oc_C 2. Reduce DC brake duty (A-19, A-23)
OC-C / oc_C	● Over current or output short circuit during speed steady state	1. Disconnect output wiring (U, V, W) 2. Test run inverter (no motor) 3. Check motor coil resistance 4. Check motor insulation
OC-d / oc_d	● Over current or output short circuit during speed deceleration	1. Check the same as OC-C / oc_C 2. Extend deceleration time (A-11)
Remark: ● OC-A, OC-b, OC-C, OC-d are hardware trip. The trip level depends on IPM power module. ● oc_A, oc_b, oc_C, oc_d are software trip. The trip level is 200% of rated inverter current.		
-OH-	● Cooling fin over heat 220V series: ~100°C (recovery at 85°C) 380V series: ~110°C (recovery at 90°C)	1. Check cooling fan 2. Check ambient temperature
-OU-	● DC bus over voltage 220V series: 400VDC 380V series: 800VDC	1. Check input voltage level 2. Extend deceleration time (A-11) 3. Connect braking resistor or using braking unit
-LU-	● DC bus under voltage 220V series: 175VDC 380V series: 310VDC	1. Check input voltage level 2. Check power source and wiring 3. Check pre-charge contactor

Fault	Description	Corrective action
-PL-	● Input voltage drop or phase loss. ● Frequency out of range 47-63 Hz in line /inverter change-over operation.	1. Check input voltage level. 2. Check frequency of line input. 3. Check inverter magnetic contactor.
-tO-	● Modbus communication loss time out when time out action is selected.	1. Check external device communication. 2. Check signal line RJ11 is connected.
OL-1	● Thermal overload terminal (THR) is not closed with CM.	1. Check contact between THR and CM. 2. Check external thermal overload level setting.
OL-2	● Inverter output current exceeded the electronic thermal overload level for a long time.	1. Check level in Electronic thermal overload (D-01) 2. Reduce load of motor. 3. Up size inverter appropriately.
Err1	● Multi-function digital input terminals are set duplicate.	● Check parameters in function C-00 to C-04 must not be duplicated.
Err2	● Set point and feedback of PID mode is set improper.	● Check parameters in function A-04 must not duplicate with E-05.
Err3	● Phase sequences of input and output voltage are not consistent in line/inverter change-over operation.	● To alternate the line input (R, S, T) or the line output (U, V, W) only one pair.
-En-	● Encoder pulses loss in vector control mode	1. Check wiring between inverter and encoder. 2. Check signal A and B of encoder.
-nC-	● Output inverter (U, V, W) are not wiring.	1. Check wiring between inverter and motor. 2. Check motor current should more than 5% of rated inverter current.
CPU, Sci	● Keypad communication loss	1. Check signal line of keypad. 2. Power on inverter again.
EEP	● EEPROM data are abnormal	1. Protect noise signal such as connect capacitor to magnetic contactor coil. 2. Power on inverter again.

MODEL AND SPECIFICATIONS

220V series

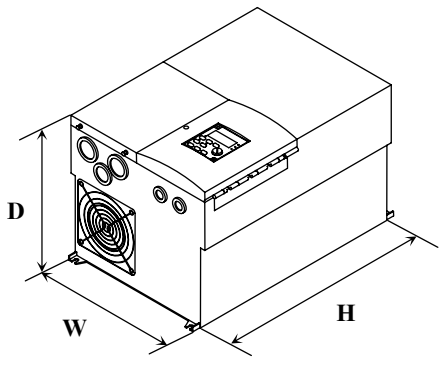
Application motor (kW)		0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37
Rating	Type	F□□□i-2HE												
	Model (HP)	0.5	001	002	003	005	008	010	015	020	025	030	040	050
	Rating current (A)	3.2	5	8	11	17	25	33	48	60	78	84	113	138
	Rating output voltage	3Ø 0V to 240V (The max. output voltage is the same as input voltage)												
Electrical braking	Dynamic braking circuit	Install												Option
	Dynamic braking resistor	Option												
Input power	voltage/frequency	1Ø and 3Ø 200V~240V, 50/60Hz					3Ø 200V~240V, 50/60Hz							
	Type of electrical supply system	This equipment can be used with the electrical supply system TN, TT or IT												
	Tolerance	Voltage +10 / -15%, Frequency ±5%												
Protection	Bus over voltage trip	400VDC												
	Bus under voltage trip	175VDC												
	Nominal Bus Voltage	320VDC												
	Heat Sink Thermistor	Limited 100°C (Recovery at 85°C)												
	Drive Over load Trip	Limited 150% of motor rated current in 1 min												
	Output short-circuit current	limited at 200% of full load current												
	Short-circuit designation	Short-circuit proof by control circuit												
	External control circuit terminals	Protection of the external control circuit terminals by means of protective impedance and limited voltages												
Earth leakage		The earth leakage current in normal working condition: Max. 2mA (0.5HP – 5HP)												
Agency Certification		The drive is designed to meet applicable requirements of the following codes/standards: EN61800-5-1 Adjustable speed electrical power drive systems - P.5-1: Safety requirements-electrical, thermal and energy												
	CE	Marked for all applicable European Directives EMC Directive (89/336/EEC) Emissions: EN 61800-3 Adjustable Speed electrical power drive systems Part 3 Immunity: EN 61800-3 Second Environment, Restricted Distribution Low Voltage Directive (73/23/EEC)												
Enclosure		IP20												
Cooling method		Forced air cooling												
Case		BP-08	BP-08	BP-08	BP-08	BP-08	M20	M20	M40	M40	M60	M60	M100	M100
Weight (kg.)		1.94	1.94	1.95	2.05	2.30	10.4	10.4	18.1	18.3	-	-	-	-

400V series

Application motor (kW)		0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45	55	75	110	150	180	220	260	300
Rating	Type	F□□□i–4HE																				
	Model (HP)	001	002	003	005	008	010	015	020	025	030	040	050	060	075	100	150	200	250	300	350	400
	Rated current (A)	3.44	4.6	6.2	9.0	14	18	27	34	44	48	65	80	96	128	165	224	302	378	454	500	570
	Rated output voltage	3Ø 0V to 460V (The max. output voltage is the same as input voltage)																				
Electrical Braking	Dynamic braking circuit	Install											Option									
	Dynamic braking resistor	Option																				
Input power	Voltage/Frequency	3Ø 360V to 460V, 50/60Hz																				
	Type of electrical supply system	This equipment can be used with the electrical supply system TN, TT or IT																				
	Tolerance	Voltage +10 / -15%, Frequency ±5%																				
Protection	Bus over voltage trip	800VDC																				
	Bus under voltage trip	305VDC																				
	Nominal Bus Voltage	540VDC																				
	Heat Sink Thermistor	limited 110°C (Recovery at 90°C)																				
	Drive Over load Trip	Limited 150% of motor rated current in 1 min																				
	Output short-circuit current	limited at 200% of full load current																				
	Short-circuit designation	Short-circuit proof by control circuit																				
	External control circuit terminals	Protection of the external control circuit terminals by means of protective impedance and limited voltages																				
Earth leakage		The earth leakage current in normal working condition: Max. 2mA (1HP – 10HP)																				
Enclosure		IP20																				
Cooling method		Forced air cooling																				
Case		BP-08				M10		M20		M40			M60		M100		WP200		WP400			
Weight (kg.)		2.05	2.05	2.05	2.25	6.75	6.75	10.4	10.4	18.1	18.3	18.3	31	33	72	80	210	270	300	350	-	-

DIMENSION

Model	BP-08	M10	M20	M40	M60	M100	WP200	WP400
W	145	218	260	280	350	500	750	850
H	195	215	287	390	584	630	1410	1765
D	150	210	190	250	260	330	410	510



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